MODELLING CHANGES IN EASTERN MEDITERRANEAN OCEAN CLIMATE FOR THE EARLY HOLOCENE

Fanny Adloff [1]* and Uwe Mikolajewicz [1]
[1] Max-Planck-Insitut fuer Meteorologie, 20146, Hamburg, Germany - fanny.adloff@zmaw.de

Abstract
We use the ocean general circulation model MPIOM to simulate the changes in hydrography and circulation for the eastern Mediterranean Sea during the early Holocene 'climatic optimum'.
Keywords: Paleoceanography, Eastern Mediterranean, Circulation Models, Hydrography

During the Holocene, a series of changes in the conditions of the Mediterranean hydrography occurred, essentially led by the orbitally-induced changes in the insolation. This study aims to investigate these changes. We focus on the Mediterranean because this semi-enclosed basin has large-amplitude reactions to external forcings. To understand the sensitivity of the Mediterranean Sea to high- and low-latitude climate forcings and to estimate the response to expected global change, we are modelling the Mediterranean Sea at different time slices of the Holocene. We set up a regional version of the general ocean circulation model MPIOM for the Mediterranean (26 km horizontal resolution, 29 levels). We forced the model with atmospheric data derived from equilibrium time slice simulations with the coupled atmosphere-ocean-dynamical vegetation model ECHAM5/MPIOM/LPJ. The experiments are performed for both time periods 6000 years and 9000 years before present as well as for the pre-industrial conditions (500 years of integration for each). Diverse proxy records available from the marine cores are used for the validation of our simulations. The effect of insolation and fresh water input changes on the Mediterranean ocean climate for the Holocene are analyzed. The amplitude of the SST seasonal cycle is stronger, leading to colder winters with a resulting cooling of the deeper layers. The enhanced summer warming is restricted to the very uppermost layers leading to a strong vertical temperature gradient. For 9000 years BP, the increased Nile runoff (due to the enhanced North-African monsoon) is overcompensated by the missing outflow from the Bosphorus and the location of Aegean deep water formation is shifted westward. For the 6000 years BP, the Nile runoff is enhanced as well and the outflow from the Black Sea is reduced due to drier climatic conditions in SE Europe. The model results are compared to available SST/SSS reconstructions derived from paleoproxy data.

References
1 - Schmiedl and Hemleben, 1998. Impact of climatic changes on the benthic formaliniferal fauna in the Ionian Sea during the last 330,000. Paleoceanography. Vol. 13, No. 5, 447-458 (scientific paper).

RAPID CHANGES IN THE SEDIMENTARY REGIME FOLLOWING THE DAMMING OF THE NILE: INNER SHELF OF THE DISTAL PART OF THE NILE LITTORAL CELL, ISRAEL

Ahuva Almogi-Labin [1]*, Barak Herut [2] and Amir Sandler [1]
[1] Geological Survey Of Israel, Jerusalem, 95501, Israel - almogi@gsi.gov.il
[2] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa 31080, Israel

Abstract
In the past the Nile floods transported large quantities of fine-grain sediments and nutrients at the end of each summer to the inner shelf of Israel which is part of the Nile littoral cell. In order to determine the influence of the damming of the Nile on the sea floor 9 short cores (~30cm) were taken at ~40m in a S-N transect. The sediments, dated by Lead-210, significantly coarsen in the post-Aswan High Dam period with 5-10 times increase in >63μm size fraction, ~50% increase in $CaCO_3$, ~50% decrease in total organic carbon and ~2.5‰ decrease (-19.5 to -22) in δ^{13}Corg. These parameters indicate a rapid and large scale change in the sedimentary regime and increasing oligotrophy during the last ~40 years, with far reaching implications for the future of the southeastern Mediterranean.
Keywords: Continental Shelf, Nile Delta, Eastern Mediterranean, Sediment Transport

Introduction
The southern inner shelf of Israel is located in the distal part of the Nile littoral cell. Until recently most of the sediments in the 30-50m silt belt [1] were derived from the Nile floods that reached the Israeli coast at the end of each summer by the alongshore northward current [2]. During the last century a series of dams were built along the Nile and since the operation of the Aswan High Dam almost all the discharge to the southeastern (SE) Mediterranean stopped, including ~10^7 tones/y of fine sediments [3]. This completely changed the hydrological and biological regime in the SE Mediterranean turning it into a hyper-oligotrophic sea. In this study we intend to characterize the consequences of the shut down of the Nile River discharge to the SE Mediterranean and examine the post-Aswan High Dam sedimentation pattern in the middle part of the inner shelf of Israel, an area which is considered to be highly affected by these recent man-made changes.

Material and Methods
Nine short cores were sampled along ~160 km of Israel inner shelf from off Ashqelon in the south to off Acre in the north. The sediments were taken from the silt belt at 35-40m water depth, an area most sensitive to changes in Nile River discharge [1]. The sediments were cut into 1 cm thick slices, lyophilized and then analyzed for granulometry, clay mineralogy, major and trace elements, $CaCO_3$ and total organic carbon (TOC) content and δ^{13}Corg. Chronology was determined in three cores using Lead-210.

Results and Discussion
The inner shelf of Israel is an integral part of the Nile littoral cell and is located on its distal part under the affect of the alongshore northward current [4]. In the past, this current transported Nile derived nutrients and fine sediments to the Israeli coast [2]. The sediment regime of the inner shelf is expected to directly record changes in Nile discharge resulting from its damming during the last century. The top ~10 cm, which accumulated during the last ~40 years are significantly coarser than the underlying pre-Aswan High Dam sediments. The sand content exceeds 60% in post-Aswan High Dam compared to <10% in the pre-Aswan High Dam sediments (Fig. 1). Grain size mode increased gradually from ~5μm in the pre-Aswan High Dam to ⩾85μm in the post-Aswan High Dam sediments. Silt fraction, comprising ~75% in the pre-Aswan High Dam sediments decreased to ~45% in the post-Aswan High Dam sediments and clay content decreased by ~50%, from ~20% to <10%. The coarsening in grain size is more abrupt and rapid in the southern shelf, closer to the Nile, than in the northern distal part. In the later, the coarsening starts earlier, is more gradual and increases in two steps apparently as a response to an earlier stage of damming of the Nile that was hardly recorded in the southern shelf.

Sediment coarsening is also accompanied by a distinct but moderate increase in $CaCO_3$, from less than 10% to 15-20% in the southern shelf and to ~80% in the most distal northern part. TOC content of 0.8-1wt.% with δ^{13}Corg of about -19.5‰ in pre-Aswan High Dam sediments decreased to less than 0.5wt.% TOC and about -22‰ δ^{13}Corg in the overlying younger sediments. The decrease in these variables reflects a major change in the regional nutrient budget and a major decrease in primary production that coincides with the damming of the Nile [3]. The trend of increasing oligotrophy in the inner shelf of Israel differs from recent reports on a major anthropogenic contribution of nutrients that supports increasing fishery in the Mediterranean coastal waters off Egypt [5]. This increase in fertility seems to be of local scale restricted mainly to the delta area, unlike the pre-Aswan High Dam summer floods that were of significant and large magnitude and affected annually the Israeli shelf.

The decrease in TOC and δ^{13}Corg, indicators of nutrient supply and primary production, predates the sharp sediment coarsening. This may indicate that earlier phases of Nile damming had already contributed to the increasing oligotrophy of the SE Mediterranean, which accelerated after the operation of the Aswan High Dam.

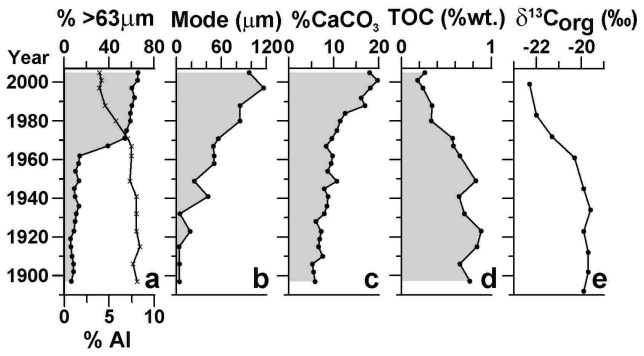


Fig. 1. Sediment dynamics in the last ~100 years at the distal part of the Nile littoral cell (southern shelf of Israel): (a) % >63μm size fraction (circle) and % Al (x); (b) Grain size mode (μm); (c) % CaCO3; (d) TOC (wt.%); (e) δ^{13}Corg (‰). Note that the major change in the sedimentation pattern coincides with the operation of Aswan High Dam at 1965

References
1 - Nir, Y., 1984. Recent sediments of the Israel Mediterranean Continental Shelf and Slope. Department of Marine Geology, Goteborg University, Sweden, 149 pp. [Ph.D. Dissertation].
2 - Hecht, A., 1964. On the turbulent diffusion of the water of the Nile floods in the Mediterranean Sea. *Bull. Sea Fish. Res. Stn. Haifa*, 36, 24 pp.
3 - Halim, Y., Morcos, S.A., Rizkalla, A. and El-Sayed, M.K., 1995. The impact of the Nile and the Suez Canal on the living marine resources of the Egyptian Mediterranean waters (1958–1986). In: Effects of riverine inputs on coastal ecosystems and fisheries resources, Food and Agriculture Organization of the United Nations, Rome, FAO Fisheries Technical Paper 349
4 - Rosentraub, Z., and S. Brenner., 2007. Circulation over the southeastern continental shelf and slope of the Mediterranean Sea: Direct current measurements, winds, and numerical model simulations. *J. Geophys. Res.*, 112, C11001, doi:10.1029/2006JC003775.
5 - Nixon, S.W., 2003. Replacing the Nile: are anthropogenic nutrients providing the fertility once brought to the Mediterranean by a great river? *Ambio*, 32: 30-39.

QUATERNARY MASS-MOVEMENTS ON THE ALMERIA MARGIN AND ADJACENT ALBORAN TROUGH (ALBORAN SEA-SW MEDITERRANEAN)

B. Alonso [1]*, G. Ercilla [1], F. Estrada [1], D. Casas [2], M. Garcia [3], J. T. Vázquez [4], M. Yenes [5] and M. Farran [1]
[1] Instituto de Ciencias del Mar, CSIC, Barcelona (Spain) - belen@icm.csic.es
[2] Instituto Geológico y Minero de España, Madrid (Spain)
[3] Ifremer, Brest (France)
[4] Instituto Español de Oceanografía, Málaga (Spain)
[5] EPS Zamora, Universidad de Salamanca, Zamora (Spain)

Abstract
Based on new multibeam bathymetric data and high and ultrahigh resolution seismic-reflection profiles, different types of mass-movement deposits have been mapped in three geomorphological environments (seamounts, valley walls and open slope) of the Almeria margin and adjacent Alboran Trough. Different factors have been invoked to explain the triggering of theses mass-movements.
Keywords: Alboran Sea, Stratigraphy, Western Mediterranean, Sedimentation, Acoustics

Introduction

Mass-movement deposits of various types and sizes have been described in different sectors of the NW Mediterranean Sea as for example in the Balearic Islands, Ebro margin, and Gulf of Lion (1). But few examples have been studied in the SW Mediterranean Sea (2, 3) in spite of mass-movements represent an important process in shaping its margins. The present study focuses on the Quaternary mass-movement deposits of the Almeria margin and adjacent Alboran Trough in the eastern Alboran Sea (SW Mediterranean) which is a tectonically active area characterised by a complex morphostructure with margins, basins, and seamounts.To analyse the morphologies and distribution of the mass-movements as well as to examine their relationship between sliding and the environment where they occur, a large data set including multibeam bathymetry, ultrahigh resolution seismic profiles (Topas system) and high resolution seismic profiles (Airguns) have been analysed.

Results and discussion

Mass-movements have been identified in three geomorphological environments, seamounts, open slopes, and valley walls in the Almeria margin and adjacent Alboran Trough (Figs.1 and 2).

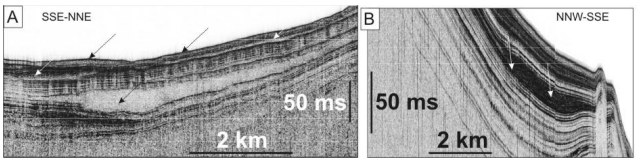


Fig. 1. Topas seismic profiles illustrating the mass movements in (A) the Sabinar Seamount and (B) the open slope environment.

The mass-movement deposits affecting to the seamounts (i) comprise slides scars and slides on the walls (10º-27º) that evolve downslope to mass-flow deposits resting on the slope break. These mass-flow deposits show a lobate shape in plan view and a lenticular geometry in cross-section and acoustically are characterized by semitransparent facies. Within the Quaternary sequence, the lobes of mass-flow deposits are vertically stacked and their size decrease progressively upward suggesting the occurrence of successive episodes of failure and their decrease in importance with time. These mass-movement deposits can be divided into two groups based on their size: small-scale (few km in length) and medium-scale (tens of km in length). The smaller deposits are identified in the Pollux, Sabinar, Gata, Maimonides, El Monsour, Yusuf, and Adra seamounts. With respect to the large-scale mass-movement deposits they have been mapped in the south flanks of the Sabinar and Pollux seamounts (Fig.1A).

In the open slope environment (ii) a buried isolated body of mass-flow deposits has been identified at 800 m water depth, where the slope gradient is about 3º. It is located close to NE-SW La Serrata fault and to WNW-ESE anticline structures, both with surficial expression. This body displays a lenticular shape and seismically is defined by chaotic facies with reflections of high reflectivity that interrupt the lateral continuity of the stratified surrounding open slope deposits (Fig.1B).

In the Almeria canyon-channel mass movement deposits (iii) include mostly slides scars, and mass flow deposits and that are identified on their walls. Here, the occurrence of mass-movement processes is also evidenced by the canyon/channel fill deposits whose seismofacies reveal ancient cut and fills features, and mass-flow deposits (Fig.2).

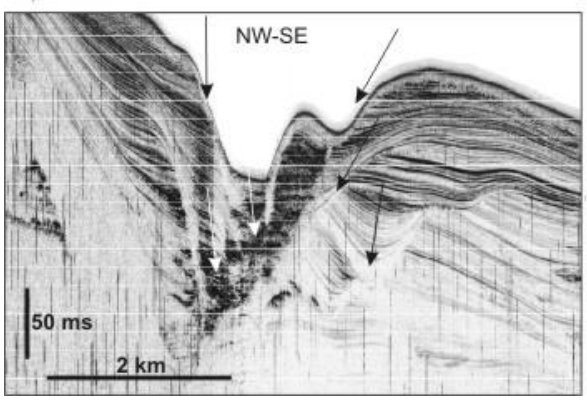


Fig. 2. Topas seismic profile illustrating the mass-movement deposits identified in the walls of the Almeria Canyon.

Different factors have been invoked to explain the triggering of mapped mass-movements. Those deposits in the seamounts and open slope environments result from the interplay of earthquake activity associated to fault activity and/or slope overstepping. While in the canyon-channel environment, the mass-movement deposits are mainly related to the erosion activity and/or the slope overstepping. The different size of the mass- movement deposits in the seamount environment is conditioned by the available run-out distances and their topography profile morphology and slope gradients.

References
1 - Stoker M.S, Evans D. and Cramp A., 1998. (eds.), Geological processes on continental margins: sedimentation, mass-wasting and stability. *Geol. Soc. Spc. Publ.*, 129, pp. 355.
2 - Muñoz A, Ballesteros, M., Montoya, I., Rivera, J., Acosta, J. and Uchupi, E. 2008. Alboran Basin, southern Spain-Part I: Geomorphology. *Mar. and Petrol. Geol.*, 25: 59-73.
3 - Ercilla G., Estrada F., Yenes M., Casas D., Alonso B., Farran F. and SAGAS TEAM., 2009. The Baraza slide, defining its dynamic. International Conference on Seafloor Mapping for Geohazard Assessment. *Ischia Island/Rend. Online Soc, Geol. It.*, pp. 163-165.

FORAMINIFERAL DISTRIBUTION IN THE KARSTIC ZRMANJA RIVER ESTUARY (EASTERN ADRIATIC SEA)

D. Bogner [1]*, S. Živkovic [2], N. Bojanic [1], A. Smoljan [3] and O. Vidjak [1]
[1] University Centre for Marine Studies
[2] Energy Institute Hrvoje Požar, 10001, Zagreb, Croatia
[3] Institute of Oceanography and Fisheries, 21000, Split, Croatia - bogner@izor.hr

Abstract
The foraminiferal taxonomic composition and density, granulometric composition, carbonate and organic matter contents were determined in recent surface sediments of the Zrmanja river estuary in June 2008. The results indicate that foraminiferal distribution strongly depends on location in the estuary and organic matter and carbonate contents, and granulometric composition of the sediments.
Keywords: Adriatic Sea, Estuaries, Foraminifera, Sediments

INTRODUCTION
This study was conducted at twelve stations in the Zrmanja river estuary, which is located in the north part of Dalmatia (eastern Adriatic coast). The Zrmanja river is approximately 69 km long and discharges into the Adriatic Sea, forming a highly stratified estuary [1]. The estuary can be divided in the upper (river Zrmanja from Jankovic buk to Novigrad Sea), middle (Novigrad and Karin Sea) and lower part (Velebit channel and the strait between Novigrad and coastal Adriatic Sea) [2]. The correlation between foraminiferal assemblages and sedimentary facies has been determined in estuarine and continental shelf areas [3,4], therefore we aimed to determine the relationships between foraminiferal distribution and chemical and granulometric composition of the sediments in the Zrmanja estuary.

MATERIALS AND METHODS
Surface sediment samples (0-2 cm) were collected using Van Ween grab in June 2008. The sediment was immediately frozen, stored at -20 °C and freeze-dried in the laboratory. Foraminifera were counted in the fraction larger than 125 µm, in the aliquots containing about 300 foraminiferal specimens. The granulometric composition, carbonate and organic matter contents in the sediment were analysed as described in the reference [5;

RESULTS AND DISCUSSION
Based on the statistical analysis of foraminiferal composition and abundances and sediment properties at the investigated stations, the results are as follows: 1) The differences between the five stations in the upper estuary sediments were considerable. Sand content decreased from Jankovic buk (97.5%) to Zrmanja mouth (10.6%). The same trend was noticed for carbonate content (34.2 and 72.3%, respectively), while portion of organic matter increased (1.13 and 6.87%, respectively). Foraminiferal density at these stations ranged from 2 to 971 specimens per 1 gram of dry sediment, and was dominated by the cosmopolitan species *Ammonia tepida* (40.8-80.2%). The other abundant taxa were *Aubignyna perlucida* (0-16.9%), *Cribroelphidium decipiens* (0-14.1%), *Elphidium* spp. (1.7- 42.1%) and *Quinqueloculina* spp. (0-10.5%). Species *Ammonia tepida* and *Aubignyna perlucida* are found in other areas with lower salinity [6,7]. The station in the strait between Novigrad and coastal Adriatic Sea had the highest gravel (37.9%) and carbonate contents (72.3%). *Connemarella rudis* (26.5%) and *Triloculina tricarinata* (14.3%) were dominant species. Presence of *Connemarella rudis* is in accordance with its preference for sandy sediment [4], while *Triloculina tricarinata*is usually found in areas with intensive circulation [8]. The six marine stations in the Novigrad Sea, Karin and coastal Adriatic Sea were characterized by the foraminiferal density between 104 and 475 specimens per 1 g of dry sediment, the highest organic matter (6.55-10.68%) and lower carbonate contents (15.8-45.9%). At these stations *Cribroelphidium decipiens* (11.1-16.5%), *Ammonia tepida* (1.6-20.8%), *Bulimina aculeata* (0.3-15.2%), *Protelphidium granosum* (0.5-10.7%) and *Asterigerinata mamilla* (0-11.8%) were dominant. Those species are associated with fine-grained sediments [4,9], and at these stations fine-grained clay particles contents were the highest (39.0-53.5%). These results indicate that in the river Zrmanja estuary foraminiferal distribution is strongly affected by the locations in the estuary, as well as by organic matter, carbonate contents, and granulometric composition of the sediment.

References
1 - Buljan M., 1969. Neka hidrografska svojstva estuarskih podrucja rijeke Krke i Zrmanje (Some hydrographical properties of rivers Krka and Zrmanja estuaries). *Krš Jugoslavije* 6: 303-331 [in Croatian]
2 - Vilicic D., 2003. Fitoplankton u ekološkom sustavu mora. (Phytoplankton in the marine ecological system). Školska knjiga. Zagreb. 146 pp [in Croatian].
3 - Gonzáles-Regalado M.L., Ruiz F., Baceta J.I., Gonzáles-Regalado E. and Muñoz J.M., 2001. Total benthic foraminifera assemblages in the southwestern Spanish estuaries. *GEOBIOS*, 34, 1: 39-51. Villeurbanne, 30.06.2001.
4 - Ferraro L., Alberico I., Budillon F. and Lirer F., 2008. The benthic foraminiferal communities of the Southern Campanian continental Shelf (Tyrrhenian Sea, Italy). 33rd International Geological Congress, Oslo 2008, August 6-14th.
5 - Bogner D., Ujevic I., Zvonaric T. and Baric A., 2004. Distribution of selected trace metals in coastal surface sediments from the middle and south Adriatic. *Fresen. Environ. Bull.*, 13 (11b): 1281-1287.
6 - Debenay J.P., Beneteau E., Zhang J., Stouff V.,Geslin E., Redois F. and Fernandez-Gonzalez M., 1998. *Ammonia beccarii* and *Ammonia tepida* (Foraminifera): morphofunctional arguments for their distinction. *Mar. Micropaleontol.*, 34: 235-244.
7 - Bernasconi M.P., Melis R. and Stanley J.D., 2006. Benthic biofacies to interpret Holocene environmental changes and human impact in Alexandria's Eastern Harbour, Egypt. *The Holocene*, 16 (8): 1163-1176.
8 - Ishman, S. E., Graham I., D'Ambrosio J. (1997) Modern Benthic Foraminifer Distributions in Biscayne Bay: Analogs for Historical Reconstructions. U.S. Geological Survey, *Open-File Report* 97-34.
9 - Mendes I., Gonzalez R., Dias J.M.A., Lobo F. and Martins V., 2004. Factors influencing recent benthic foraminifera distribution on the Guadiana shelf (Southwestern Iberia). *Mar. Micropaleontol.*, 51 (1-2): 171-192.

COASTAL WATER ASSESSMENT AND MONITORING BY HYPERSPECTRAL REMOTE SENSING TECHNIQUES: SELECTED APPLICATIONS IN THE ADRIATIC SEA

F. Braga [1]*, L. Alberotanza [1], R. M. Cavalli [2], S. Pignatti [3] and F. Santini [2]
[1] CNR Ismar, 30122, Venezia, Italy - f.braga@ismar.cnr.it
[2] Institute of Atmospheric Pollution (CNR IIA - LARA), 00133, Roma, Italy
[3] Institute of Methodologies for Environmental Analysis, CNR IMAA, 85050, Tito Scalo, Italy

Abstract
Observation of coastal areas may address to different aspects of the environment such as parameters and processes of water quality, hydrodynamics, geomorphology, meteorology and ecology. Satellite and airborne remote sensing can provide an important contribute for assessing and monitoring the status of water quality. Selected case studies, which describe data acquisition and processing, outline improvements in the advanced methodologies and provide examples of gaps and barriers to produce useful applications in coastal areas, are presented.
Keywords: Coastal Waters, Remote Sensing, Adriatic Sea

Introduction
Coastal areas are characterized by small-scale processes, high spatial and temporal variability of the main physical and biogeochemical properties of the water, hazards and unpredictable events. These areas are very sensitive to the impact of human activities and land use in watersheds, along the coast and further inland, of fluvial discharges, and of marine processes.
Local and national authorities require innovative methods and technologies for managing coastal risks and monitoring water quality, in order to satisfy operational, spatial and qualitative requirements with a good cost-benefit ratio. In the recent decades, a helpful contribution has been obtained by the Remote Sensing data, which can significantly enhance the information available from traditional data sources providing synoptic views of large portions of Earth with a relatively high revisiting frequency and therefore early detection of anomalies and degradation of the ecological status.
Remote sensing of the bio-optical parameters can be an important way for monitoring the coastal environment. Whereas the optical properties of open ocean (Case 1 water) are primarily a function of phytoplankton concentration, coastal waters (Case 2 water) represent a more complex optical environment [1]. The optical properties in these areas are due to a mix of phytoplankton, suspended sediments, and CDOM that can vary independently from each other. Besides the water colour can be influenced by bottom reflectance and we must take account of the natural variability in the types of bottom (e.g., sand, mud, rocky, algae or seagrasses covered).
Water quality parameters may be derived from hyperspectral data [2] [3] [4].

Methodology and results
In the last years, we have investigated the capability of multi and hyperspectral remote sensing data to meet the information needs of end users in the coastal zone and we present some case studies which describe data acquisition and processing, outline improvements in the advanced methodologies and provide examples of gaps and barriers to producing useful applications.
During satellite and airborne overpasses on the Adriatic Sea (Lagoon of Venice , 2001-05; Sacca di Goro Lagoon, 2005-06; Montenegro, 2007-09, see Fig. 1), we acquired an extensive in situ data set: the field campaigns retrieved inherent optical properties, apparent optical properties, substrate reflectance spectra, and water quality parameters with advanced instruments. The efforts aim at making a first step in the construction of a feasible and timely methodology for quantitative assessment of water quality parameters detectable from hyperspectral data. The adopted analysis techniques of satellite and airborne imagery were: the empirical algorithm for CDOM/chl-a retrieval; the classification techniques for algae and submerged vegetation identification with spectral libraries; the complex physically based model that considers analytical formulations of radiative transfer equations and the application of numerical simulations (Hydrolight software).
In particular, for the Venice Lagoon the authors have been involved in the tuning of a physical model for the highly turbid Venice lagoon waters and developed an inversion technique appropriate for hyperspectral data processing to retrieve water constituent concentrations from remotely data.

Conclusions
Within the hyperspectral VIS-NIR spectral range, several parameters are detectable from space: presence/absence of algal blooms, concentration of phytoplankton with some information on content of different pigments, suspended matter and yellow substances concentrations, diffuse attenuation coefficient, water colour, water transparency and, over shallow waters, bathymetry, submerged vegetations and substrate types.

The selected applications of hyperspectral observation techniques in the Adriatic sea, financed and conducted in the framework of international projects (i.e. NERC, ESA, ASI, Italian Environmental Ministry), provide examples of the remote sensing efficiency in the field of integrated coastal environmental management.

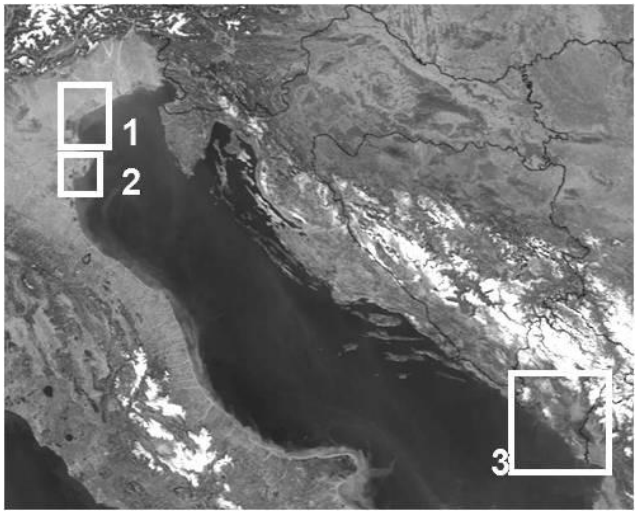


Fig. 1. Location of case studies: Lagoon of Venice (1), Sacca di Goro Lagoon (2), Montenegro coastal area (3).

References
1 - IOCCG, 2000. Remote Sensing of Ocean Colour in Coastal, and Other Optically-Complex,Waters. *In:* Sathyendranath, S. (ed.), Reports of the International Ocean-Colour Coordinating Group, No. 3, IOCCG, Dartmouth, Canad, pp.145.
2 - Brando, V.E. and A.G. Dekker, 2003. Satellite hyperspectral remote sensing for estimating estuarine and coastal water quality. *IEEE Trans. Geosci. Rem. Sens*., 41: 1378-1387.
3 - Cavalli R.M., Laneve G., Fusilli L., Pignatti S., Santini F., 2009. Remote sensing water observation for supporting Lake Victoria weed management. *J. Environ. Manage*., 90 (7): 2199-2211.
4 - Phinn S., Roelfsema C., Dekker A., Brando V., Anstee J., 2008. Mapping seagrass species, cover and biomass in shallow waters: An assessment of satellite multi-spectral and airborne hyper-spectral imaging systems in Moreton Bay (Australia). *Rem. Sens. Env*., 112 (8): 3413-3425.

MARINE MESSINIAN IN EASTERN TUNISIA

Pierre-Felix Burollet [1]*
[1] GEA, 04300, Forcalquier, France - burollet.gea@voila.fr

Abstract
Deep dessication in Western Mediterranean has been proposed in 1973 by W.B.F.Ryan and al. Leg. 13 of Joides. Subsidence in Tunisia was proven in Eastern Tunisia both in Kerkennah Islands (La Mer Pélagienne, Geol.Med.t VI.1.1979) and Eastern Tunisia on land and off shore.
Keywords: Messinian, Salinity

In Eastern Tunisia, South of Sousse, outcrops of Marine Messinian are known near Zeramedine and Bou Merdas with fossils including Bryozoa, Oysters and microfauna. They overlay the Tortonian Somaa sands and are followed by the continental Segui Formation Off-shore, above the Somaa sand there is a marine unit called Melqart Formation with a few beds of limestone and a rich Messinian microfauna. In the upper part it begins to be lagoonish with gypsum layers and is named Oued Bel Kredim Formation. They are overlain by the marine Early Pliocene Raf-Raf shale. In North East Tunisia (Bizerte and Raf-Raf area) the post-orogenic molasse presents above the Kechabta Tortonian detritic unit, the Oued Bel Kredim Formation: open marine at base with Messinian microfauna, it becomes lagoonish in the upper part and presents some lacustrine limestone layers. It is overlain, with angular unconformity, by the Early Pliocene Raf-Raf shale. It is evident that the presence of open marine Messinian sediments excludes the presence of deep holes with dessication in the Western Mediterranean. On an other hand, a thick sequence of Salt is known. The western Mediterranean was a lagoon with concentration of halite. The hypothesis of a deep dessication was due to an erroneous tectonic interpretation. In fact, there has been a regular subsidence during and after the salt sedimentation: a present rate of subsidence of 1 or 2 millimeters by year is known in numerous places around the Mediterranean.

References
1 - Burollet P.F, 1951. Les bassins mio-pliocènes de Tunisie orientale. Annales geol. et mines. Tunis
2 - Burollet P.F., 1956. Contribution à l'étude stratigraphique de la Tunisie centrale. Annales geol. et mines. Tunis

MEDITERRANEAN DEEP ANOXIC HYPERSALINE BASINS: AN OVERVIEW

Claudia Elena Casalino [1]*, Gert J. De Lange [1] and Sara Borin [2]
[1] Utrecht University, 3508 TC Utrecht, Netherlands - c.casalino@geo.uu.nl
[2] Consorzio Nazionale Interuniversitario per le Scienze del Mare (CoNISMa), Ulr Università degli Studi di Milano, 20133, Italy

Abstract
Several brine basins appear to occur in the deep waters of the Eastern Mediterranean. These are characterized by extreme environments with high pressure and density, redox conditions and saturated salt concentrations. These basins are probably the result of the dissolution of Miocene salt deposits that became exposed to seawater after tectonic activity. The high densities of the brine fluids contrast with seawater limiting the mixing with overlaying oxic seawater. As a consequence, isolated habitats evolved in which adapted microbiological life exists. Distinct differences occur between the various basins related to chemical composition and density.
Keywords: Anoxia, Eastern Mediterranean, Interfaces

At the bottom of eastern Mediterranean Sea (~3500 m water depth) several deep hypersaline anoxic brine basins have been discovered in the last 30 years. Amongst these are : Atalante (AB), Bannock (BB), Discovery (DB), Nadir (NB), Medee (MB), Tyro (TB), and Urania (UB) all names after the ships involved in their initial discovery (Fig. 1). The general composition of the brine pools resulted from the dissolution of subterranean late-Miocene evaporitic salt deposits, underlying the Mediterranean sediments . It is most likely related to the collision of the African beneath the Eurasian tectonic plate [1, 2]. Alternatively the deep submarine basins might have been formed by accretionary processes and may have subsequently been filled with fossils and highly concentrated relics of Messinian water trapped in the interstitial area of the deep-sea sediments [3]. Waters enclosed in these depressions are characterized not only by high pressure and density, but also and for most by their redox state, lack of oxygen and saturated salt concentrations. Strong salinities and density gradients prevent mixing with the oxic seawater above and hence lead to stratification of the water column forming sharp and distinctive seawater/brine interfaces of 1 - to 2 m (Fig. 2). Moreover the elevated density and salinities basically tend to reduce biodiversity [4]. Despite these extreme conditions and the limited exchanges between brine and overlying seawater, anoxic basins are not biological deserts since several microbial communities appear to have developed under these conditions, usually considered as harsh [2]. In particular the oxic/anoxic boundaries are considered to be a hot spot for biological activity where the sharp redox potential differences create favourable conditions for different types of sequential metabolic processes [3]. The main microbial reaction in the lower part of the interface is thought to be the anoxic oxidation of methane (AOM) directly coupled to the reduction of sulphate (equation 1), where sulphide oxidation and possibly ammonia oxidation are more dominant in the upper reach of the seawater - brine interface (equation 2), according to the following equation [4]: $CH_4 + SO_4^{2-}$ à $HCO_3^- + HS^- + H_20$ (eq. 1) $HS^- + 2\ O_2$ à HSO_4^- (eq. 2) According to the most recent bio-explorations the deep hypersaline basins are mostly dominated by Bacteria rather than Archaea with a great variety of microorganisms adapted to the different chemical interfaces composition. All brine basins show a relatively stable structure according to the geochemical composition and temperature gradient. Despite that, 3 specific lakes (AB, DB, UB) geographically close to each other (Fig. 1), show the largest differences in terms of geochemical composition and density. For instance in Urania concentrations of Methane and Sulfide are relatively higher, whereas the salinity is lower. The most remarkable difference is referred to the composition of Discovery mainly dominated by $MgCl_2$ in concentration considered as a limit for the life [6]. The existence of microbial life in such hostile environments suggests the high capability of microbial adaptation to salinity. It also hints to the possibility of life in other extreme environments such as the planet Mars, where the occurrence of high-salinity waters have been suggested [7]. The study of these brine basins is part of the European MIDDLE project with the general aim to investigate the extreme habitats of deep hypersaline basins of the Eastern Mediterranean Sea. Preliminary results from a multidisciplinary study of water and sediment samples collected during the 2008 DOPPIO cruise with RV Pelagia will presented.

References
1 - Camerlenghi A., 1990. Anoxic basins of the eastern Mediterranean: geological framework. *Mar. Chem.*, 31: 1-19.
2 - Van der Wielen P. W. J. J., Bolhuis H., Borin S., Daffonchio D.,et al., 2005. The Enigma of Prokaryotic Life in Deep Hypersaline Anoxic Basins**.** *Science*, 307: 121-123.
3 - Vengosh A., De Lange G.J., Starinsky A., 1998. Boron isotope and geochemical evidence for the origin of Urania and Bannock brines at the eastern Mediterranean: Effect of water-rock interactions. *Geochim. Cosm. Acta*, 62: 3221-3228.
4 - Borin S., Brusetti L., Mapelli F., D'Auria G., et al., 2009. Sulfur cycling and methanogenesis primarily drive microbial colonization of the highly sulfidic Urania deep hypersaline basin. *Proc. Natl. Acad. Sci. U.S.A.*, 106: 9151-9156.
5 - Valentine D.L., 2002. Biogeochemistry and microbial ecology of methane oxidation in anoxic environments: A review. *Anton Leeuw. Int. J. G.*, 81: 271-282.
6 - Wallmann K., Suess E., Westbrook G.H., Winckler G., et al., 1997. Salty brines on the Mediterranean sea floor. *Nature*, 387: 31-32.
7 - Altheide, T., V. Chevrier, C. Nicholson, J. Denson, 2009. Experimental investigation of the stability and evaporation of sulfate and chloride brines on Mars. *Earth Plan. Sci. Lett.*, 282: 69-78.

COMPOSITION AND ORIGIN OF HYPERSALINE EASTERN MEDITERANEAN BRINES WITH EMPHASIS TO URANIA BASIN

C. Casalino [1]*, G. De Lange [1], A. Vengosh [2], A. Michard [3], C. Corselli [4], G. Winckler [5] and K. Wallmann [6]
[1] Institute for Earth Sciences, Utrecht University, Utrecht, Netherlands - c.casalino@geo.uu.nl
[2] Research Department, Hydrological Service, Jerusalem, Israel
[3] CEREGE, Europole Méditerranéen de l'Arbois, Aix en Provence Cedex, France
[4] Department Scienze Della Terra, University of Milan, Italy
[5] Institut für Umweltphysik der Universität Heidelberg, Im Neuenheimer Feld, Heidelberg, Germany
[6] Geomar Reseatch Center, Kiel, Germany

Abstract
During the last two decades an increasing number of anoxic hypersaline lakes has been discovered in the eastern Mediterranean and characterized in successful EU projects such as PALAEOFLUX, MEDRIFF, SAP, and BIODEEP, and the French-Dutch MEDINAUT programme. Brine basins are extreme environments with one of the highest dissolved sulphide concentrations ever reported for the 'open marine' environment (up to more than 12 mM), and demonstrating large compositional differences between different brine pools: going from a nearly 5 M MgCl2 solution and below seawater Na content (Discovery Basin) to a nearly saturated 5.3 M NaCl solution(Tyro Basin). The recently discovered Nadir brine is high in NaCl, methane, and possibly sulphide, and seems rather 'recent'. The Medee Basin, recently reported, is also NaCl-rich.
Keywords: Eastern Mediterranean, Deep Sea Processes, Deep Sea Basins

One of the most extreme environments thus far discovered is Urania Basin which contains the highest radiogenic supersaturations ever observed for the marine environment (3He / 4He of 1.10-7 and 40Ar / 36Ar of 470) [1], the most extreme d11B (28‰) [2], the highest methane content (> 260 µl/ml), and the highest bottom water temperature (> 48oC). Irregular methane-driven mud-eruptions appear to occur from the latter bottom at least up to 600 m above the basin-floor, i.e. to a water depth of 2900 m. The composition of most of the brines seems to relate to a 'relict brine' or the dissolution of evaporites both originating from the Messinian period during which the Mediterranean is thought to have been desiccated (Bannock, Atalante and Tyro Basins). On the basis of various isotopes for most of these basins the 'relic brine' option seems the most plausible. In addition, the compositions of relevant major and minor elements appear to be in near coincidence with the theoretical seawater evaporation path. Urania brine is the most extreme exception to this picture, its major and minor element composition, but in particular its isotopic signature clearly relates to a source area that must be much deeper than that of the Messinian evaporites, and which is clearly influenced by high-temperature interactions with old sediment and volcanic units. In addition to their individual compositional characteristics, each brine demonstrates a typical and for most of them rather stable internal brine structure of various different brine levels. Subtle as well as outspoken temperature and compositional differences occur between the different brine levels in individual basins. The transition between different brine levels, and between brine and seawater may be relatively gradual but usually is extremely abrupt. In particular the seawater/brine transition is dramatic changing from seawater to 10x seawater concentration within a depth interval of 100 cm. The interface is further characterized by a strong dip in Transmission (= high suspended matter content, but possibly partly related to reflection of waters of different densities) [3, 4].

References

1 - Winckler, G., Suess, E., Wallmann, K., De Lange, G.J., Westbrook, G.K., Bayer, R., 1997. Excess helium and argon of radiogenic origin in Mediterranean brine basins. *Earth Plan. Sci. Lett*., 151: 225-231.
2 - Vengosh A., De Lange G.J., Starinsky A., 1998. Boron isotope and geochemical evidence for the origin of Urania and Bannock brines at the eastern Mediterranean: Effect of water-rock interactions. *Geochim. Cosm. Acta*, 62: 3221-3228.
3 - De Lange G.J., Boelrijk N.A.I.M, Catalano G., Corselli C., Klinkhammer G.P., Middelburg J.J., Ullman W.J., van Gaans P. and J.R.W Woittiez, 1990 (a). Sulphate-related equilibria in the hypersaline brines of Tyro and Bannock Basins, eastern Mediterranean, *Mar. Chem*. 31: 89,112.
4 - De Lange G.J., Catalano G., Klinkhammer G.P.and Luther III G.W.,1990 (b). The interface between oxic seawater and the anoxic Bannock brine; its sharpness and the consequences for the redox-related cycling of Mn and Ba, *Mar. Chem*. 31: 205;217.

HEAVY METALS, PAHS AND PCBS IN THE SEDIMENT OF THE VENICE LAGOON

D. Cassin [1]*, M. Botter [1], A. Pesce [1], A. Rismondo [2], R. Rosselli [3] and R. Zonta [1]
[1] SELC (Soc. Coop.), Via dell'Elettricità 3/d, 30175 Venice (Italy)
[2] Magistrato alle Acque, Servizio Informativo, San Marco 2949, 30124 Venezia
[3] National Research Council – Institute of Marine Sciences (CNR-ISMAR), Castello 1364/A, 30122 Venice (Italy) - daniele.cassin@ve.ismar.cnr.it

Abstract
The sediment of the shallow water areas of the Venice Lagoon was investigated by collecting 50 cm-long cores from 380 sites. Samples were analysed for heavy metal, polycyclic aromatic hydrocarbon (PAHs) and polychlorinated biphenyls (PCBs) contents. Pollutant concentration shows a wide variability both spatially and along the vertical profile, but not evident situation of acute contamination are observed. However, the contamination level of mercury deserves attention, its value resulting quite often above the NOAA-ERM limit.
Keywords: Metals, Pcb, Pah, Sediments, Lagoons

Sediments are widely recognized as a suitable medium for assessing environmental quality, as they both reflect and integrate contaminant inputs to the marine environment, thereby allowing sources and sinks to be investigated [1]. The lagoon of Venice is a coastal shallow waterbody with a surface of 550 km^2 and an average depth of about 1 m. The impact of the human activities affects the various shallow water areas to a different extent, in response to local water renewal and position with respect to the pollution sources. This study focused on heavy metals (Al, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb and Zn), arsenic, polycyclic aromatic hydrocarbon (PAHs) and polychlorinated biphenyls (PCBs) distributions in the sediment of the whole lagoon. In 2008, fifty centimetres-long cores were collected in 380 sampling sites (Fig.1). Each core was sliced in five parts, obtaining 1900 samples corresponding to the following depth layers: 0-5 (named layer "A"), 5-10 ("B"), 10-20 ("C"), 20-30 ("D") and 30-50 ("E") cm. Metal concentrations were determined by inductively coupled plasma atomic emission spectrometry (ICP-AES) [2]. Concentrations of 14 PAHs (USEPA *priority pollutants*) and 7 PCB congeners (named *indicator*-PCBs) were analyzed in the 760 samples from layers "A" and "B" with high performance liquid chromatography (HPLC) and by capillary gas chromatography (GC), respectively [3]. Analyses of grain-size distribution and nutrient (C, N, P) contents were also performed. The obtained 3D dataset updates and upgrades the knowledge on the lagoon sediment characteristics, and permits to investigate their spatial and temporal variations as well as quality conditions with a great detail. Pollutant concentration shows a wide variability both spatially and along the vertical profile. Higher metal concentrations (particularly Cd, Cu, Hg, Pb and Zn) are found in the correspondence of knew sources (freshwater tributary inlets, industrial area, city of Venice), but also new situations of sediment contamination are evidenced in some areas. Mean concentration values calculated in the five sampling layers (Table 1) give a first picture of the contamination level of the whole lagoon sediment. For comparison, the table also shows the percentage distribution of concentration data measured in the 1900 samples with respect to the NOAA sediment quality guidelines (SQGs): effect range-low (ERL) and effect range-median (ERM) [4]. Arsenic, Cd and Ni concentration exceeds the ERL value in a significant number of samples (37%, 29%, and 16% respectively). However, the most relevant outcome is the high concentration of Hg, which exceeds the ERL and the ERM values in 76% and 27% of the samples, respectively. Concerning the two superficial layers, it is worth to observe that the mean concentration in "A" is lower by about the 10% with respect to "B", for all metals. Mean PAH and PCB concentrations, instead, do not show variation with the depth.



Fig. 1. Location of the 380 sampling sites

Tab. 1. Average concentration (mg/kg, dry weight) of contaminants in the five investigated sediment layers. The last three columns report the percentage distribution of the 1900 samples with respect to the NOAA-SQGs.

	Sediment layer							
	A	B	C	D	E	< ERL	ERL - ERM	> ERM
As	6,6	7,5	8,3	9,1	9,3	63	37	0
Cd	1,2	1,4	1,3	1,3	1,1	71	29	1
Cr	16	17	18	19	19	100	0	0
Cu	19	21	21	21	19	92	8	0
Hg	0,51	0,55	0,54	0,49	0,39	24	49	27
Mn	239	250	265	278	279	-	-	-
Ni	13	14	15	16	17	84	16	0
Pb	15	17	17	17	15	99	1	0
Zn	90	103	107	105	72	87	10	3
ΣPAH	0,36	0,35	-	-	-	99	1	0
ΣPCB	0,006	0,006	-	-	-	98	2	0

References
1 - ICES 1989 Report of the ICES Advisory Committee on Marine Pollution. ICES Co-operative Research Report 167, Copenhagen.
2 - EPA Method 2007, "Determination of Metals and Trace Metals in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry," Revision 4.4, 1994. Environmental Monitoring Systems Laboratory, Office of Research and Development, United States Environmental Protection Agency, Cincinnati, OH 45268.
3 - Fossato V.U., Campesan G., Craboledda L., Dolci F. e Stocco G., 1996. Organic micropollutants and trace metals in water and suspended particulate matter. In Lasserre P. e A. Marzollo (ed.) Venice Lagoon Ecosystem, Unesco/Murst, Vol. 1, 8 p.
4 - Long E.R., MacDonald D.D., Smith S.L., Calder F.D., 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environment Managing*, 19, 81–97.

EXPLORING SEABED SEEPAGE FEATURES ON THE CALABRIAN ACCRETIONARY PRISM

S. Ceramicola [1]*, A. Caburlotto [1], M. Coste [1], A. Cova [1], D. Praeg [1], E. Forlin [1], D. Civile [1], P. Diviacco [1], J. Centonze [1], D. Cotterle [1], D. Accettella [1], N. Wardell [1] and L. Chiocci [1]

[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, 34010, Trieste, Italy - sceramicola@ogs.trieste.it

Abstract

The distribution of cold seeps in relation to the seabed tectonic features of the Calabrian Arc is examined using multibeam data.Integration of swath bathymetry with backscatter data indicates the presence of at least 40 seepage sites, recognized as sub-circular to elongate high backscatter patches of varying form *(e.g. cones, calderas, domes, pies, scarps).* Many resemble mud volcanoes, proven at several sites by seismic and core data. Most cold seeps lie on the inner to central Arc, a distribution inferred to reflect the long-term dynamics of the accretionary prism.

Keywords: Mud Volcanoes, Swath Mapping, Active Margins, Geomorphology

A new Mediterranean cold seep province was discovered offshore southern Italy during the summer 2005 campaign of the Italian research vessel OGS Explora, which acquired the first regional multibeam coverage of the Calabrian accretionary prism [1, 2]. Detailed investigations at two sites provided seismic and sample evidence of tectonically-driven mud volcanism since the late Pliocene [3]. These two sites were further investigated during two campaigns equipped with remotely-operated vehicles (ROVs), which found seabed evidence of geological and biological seepage activity [4, 5]. Here we present new information regarding the wider distribution of cold seeps across the accretionary prism in relation to its main tectonic features.

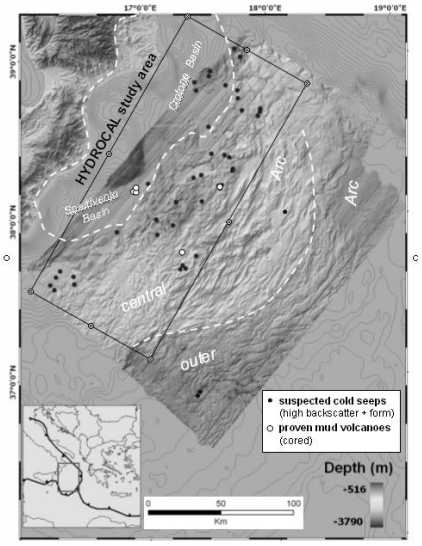


Fig. 1. Distribution of seepage sites across the Calabrian accretionary prism as inferred from integration of multibeam swath bathymetry and backscatter data

Multibeam data across water depths of c. 1000-4000 m reveal the main seabed tectonic features of the Calabrian Arc, within three main zones [cf. 6]: inner forearc basins (Spartivento-Crotone), a central thrust-fold belt and the outer cobblestone area (underlain by Messinian evaporites). Integration of swath bathymetric and backscatter data indicates the presence of at least 40 sites of seabed seepage across the inner and central Arc, recognized as sub-circular to elongate high backscatter patches of varying form. Some features lie along linear trends that appear to correspond to seabed fault scarps. Many features have forms that resemble mud volcanoes (cones, calderas, domes, broad pies). Mud volcanoes (MVs) are proven at three main sites by cores of mud breccias, complemented by seismic profiles: the Madonna dello Ionio MVs (including three extrusive centres, 1.5-3 km in diameter), the Pythagoras mud volcano (a mud pie up to 9 km in diameter) and the Sartori MV (a small dome c. 1.5 km across). The latter is identified from cores of 'chaotic sediments' recovered in 1981 and originally interpreted as tectonic breccias [7]. The former two features have been shown to be the tops of subsurface extrusive edifices >1 km thick that record extrusive activity and subsidence over several million years, triggered by the rise of fluids from deep within the accretionary prism [3]. This model of tectonically-driven fluid escape is consistent with the observed distribution of cold seeps, which (as on the Mediterranean Ridge) are absent on the outer Arc where thick evaporites have been incorporated into the accretionary prism.

Seabed investigations of the Madonna and Pythagoras mud volcanoes provide evidence of ongoing seabed seepage of gas (methane) and warm mud, in places supporting chemosynthetic ecosystems [4, 5]. Gas seepage is also indicated by acoustic data acquired by OGS in 2009 across a mud volcano 6 km offshore Catanzaro Marina (Calabria , Italy). At present we have no information as to how many other seepage sites on the Calabrian Arc are currently active, whether gas hydrates are present, the type and quantities of gases and/or fluids that are being released into the water column, or the forms of chemosynthetic microbial and macrofaunal life that may be supported by seabed emissions of hydrocarbons. Preparations are underway to undertake further multidisciplinary investigations of seabed hydrocarbon seepage in the Calabrian Arc cold seep province (OGS HYDROCAL proposal).

References

1 - Ceramicola, S., Praeg, D., the OGS Explora Scientific Party 2006. Mud volcanoes discovered on the Calabrian Arc: preliminary results from the HERMESHYDRAMED IONIO 2005 campaign. *CIESM Workshop Monographs* 29, 35–39.

2 - Ceramicola, S. & Praeg, D., 2007. Una nuova provincia di vulcani di fango scoperta nel Mar Ionio. *GeoItalia* 19, 18–22.

3 - Praeg, D., Ceramicola, S., Barbieri, R., Unnithan, V. & Wardell, N. 2009. Tectonically-driven mud volcanism since the late Pliocene on the Calabrian accretionary prism, central Mediterranean Sea. *Marine and Petroleum Geology*, 26, 1849–1865; doi:10.1016/j.marpetgeo.2009.03.008.

4 - Foucher, J.-P., Westbrook, G.K., Boetius, A., Ceramicola, S., Dupré, S., Mascle, J., Mienert, J., Pfannkuche, O., Pierre, C. & Praeg, D., 2009. Structure and drivers of cold seep ecosystems. *Oceanography*, 22 (1), 92-109

5 - Praeg, D., Ceramicola, S., Pierre, C., Mascle, J., Dupré, S. & 15 others (*this meeting*). Evidence of active mud volcanism on the Calabrian accretionary prism, Ionian Sea. 39th CIESM Congress, Venice.

6 - Rossi, S., Sartori, R., 1981. A seismic reflection study of the external Calabrian Arc in the northern Ionian Sea (eastern Mediterranean). *Marine Geophysical Researches* 4, 403–426.

7 - Morlotti, E., Sartori, R., Torelli, L., Barbieri, F., Raffi, I., 1982. Chaotic deposits from the external Calabrian Arc (Ionian Sea, eastern Mediterranean). *Memorie della Societa` Geologica Italiana* 24, 261–275

SEABED FEATURES IN RELATION TO GEOHAZARDS ON THE IONIAN CALABRIAN MARGIN: RESULTS FROM THE MAGIC PROJECT

S. Ceramicola [1], A. Caburlotto [1]*, M. Coste [1], A. Cova [1], S. Migeon [2], E. Forlin [1], D. Praeg [1], P. Diviacco [1], D. Cotterle [1], R. Romeo [1], L. Facchin [1], D. Civile [1], R. Ramella [1], S. Critelli [3] and F. Chiocci [4]

[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, 34010, Trieste, Italy - acaburlotto@ogs.trieste.it

[2] Université de Nice-Sophia Antipolis, UMR GéoAzur, 06235, Villefranche sur Mer, France

[3] Università degli Studi della Calabria, Dipartimento di Scienze della Terra, 87036, Arcavacata di Rende, Italy

[4] Università "La Sapienza" , Dipartimento di Scienze della Terra, 00185, Roma, Italy

Abstract

Theseabed dynamics of the Ionian Calabrian Margin are currently being examined in the context of the project MAGIC (Marine Geohazards along the Italian Coasts). Multibeam and shallow seismic data show that the seafloor within X km of the Calabrian coast is characterized by the presence of canyons, slump, slides, diapirs, mud volcanoes and cold seeps. The presence of these morphologies, indicative of ongoing processes of sediment transfer and fluid flow, makes this area particularly interesting in relation to assessments of seafloor geohazards.

Keywords: Ionian Sea, Continental Margin, Geomorphology

The Ionian Calabrian Margin (ICM, Fig.1) is a tectonically active convergent margin, the structures of which reflect two main processes: frontal compression and fore-arc extension during the SE advance of the Calabrian accretionary prism since the late Miocene[1]; and a rapid uplift (up to 1 mm/yr) of onshore and shallow shelf areas since the mid-Pleistocene [2].

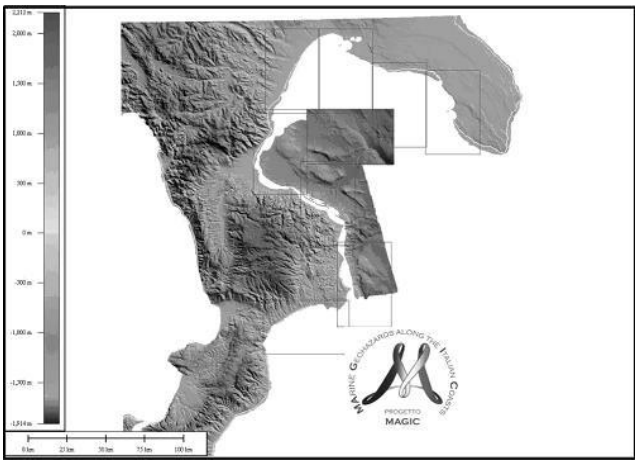


Fig. 1. Bathymetric map of the Ionian Calabrian Margin

The morphological expression of these processes at seabed is a broad, irregular offshore area that comprises the southern Apennine fold-and-thrust-belt, overlain southwards by the Spartivento-Crotone fore-arc basins. The IMC is currently being investigated in the framework of the MAGIC project (Marine Geohazards along the Italian Coasts). The objectives of the project are the definition of elements that may constitute geological risks for coastal areas. This study is based on geophysical data acquired by the r/v OGS Explora in summer 2005 in the framework of the WGDT project, carried out in collaboration with Universities of Calabria and Trieste, and in Spring 2009 in the framework of the MAGIC project. The dataset consists of a swath bathymetry DEM with variable cell size (5-50 m), plus Chirp sub-bottom profiles (2-7KHz) and available multichannel seismic (MCS) reflection data (Ministeriali Zona F) [3], [4]. The interpretative method adopted at OGS for MAGIC consists of mapping seabed morpho-bathymetric elements in relation to the acoustic facies of near-seabed sediments identified on the sub-bottom data. This allows the identification of the principal depositional and erosional features on the margin, as well as indicators of recent seismo-tectonic activity. This approach has been used to construct maps of morphological lineaments and units in order to assess principal sites of geological risk. Morphologically, the seabed of the ICM is characterized by a narrow (in places absent) continental shelf above depths of c. 150 m, above a slope of irregular morphology that extends to depths of 2000 m. In the north, the slope is broad and dominated by the ridges and intervening basins (e.g. Amendolara Ridge and Basin, Corigliano Basin), which are morphological expressions of the southern Apennine fold-and-thrust belt. The fold-and-thrust belt is overlain to the south by the late Miocene-Pleistocene deposits of the Crotone basin. The northern area includes two main canyon systems (Corigliano and Neto) that feed into the Taranto valley. The main geological risks identified along the ICM during the first two years of the MAGIC project are the retrogressive headwall activity of the Capo Colonna, Esaro, Neto, Punta Alice e Capo Trionto canyons along the southern part of the margin in proximity to the coastline. Other possible risks are are due to the presence of canyons, slump, slides, diapirs, mud volcanoes and cold seep and their relative proximity to the coastline.

References

1 - Sartori, R., 2003. The Tyrrhenian back-arc basin and subduciton of the Ionian lithosphere. *Episodes*, 26(3), 217-221.

2 - Westaway, R., 1993 Quaternary uplift of southern Italy. *J. Geophys. Res.*, 98, 21741-21772.

3 - Ceramicola S., D. Civile, A. Caburlotto, A. Cova, D. Accettella, M. Caffau, D. Cotterle, P. Diviacco, N. Wardell, R. Ramella., 2008. Dinamiche morfo-sedimentarie del margine calabro ionico settentrionale per definire il rischio geologico (Progetto MaGIC). Extended abstract of the 84° Congresso della Società Geologica Italiana, 15-17 settembre 2008 Sassari, Italy p. 210-11.

4 - Ceramicola S., Civile D., Caburlotto A., Cova A., Cotterle D., Diviacco P., Caffau M., Praeg D., Accettella D., Colizza E., Critelli S., Cuppari A., Dominici R., Fanucci F., Morelli D., Muto F., Romano C., Ramella R., 2008. Features of mass wasting along the submarine scope of the Ionian Calabrian margin, Extended abstract (Vol. 7) of the International Conference on Seafloor Mapping for geohazard assessment; 11-13 May 2009, Ischia, Italy; p. 87-89.

PALYNOLOGICAL STUDY OF CLIMATIC AND OCEANIC VARIABILITY DURING "ROMAN WARM PERIOD" IN EASTERN MEDITERRANEAN

Liang Chen [1]*, Karin Zonneveld [1] and Gerard Versteegh [1]
[1] Fachbereich-5, Geowissenschaften, Universität Bremen, 28215, Bremen, Germany - lichen@uni-bremen.de

Abstract

.
Keywords: Primary Production, Paleoceanography, Temperature

To date there is a strong debate about the question if the current rise in global temperature is in range of the normal climatic "noise" or if it is a significant positive anomaly. A way to obtain more insight into this question is by studying past time intervals where potential analogue conditions existed. One of these time intervals is the "Roman Warm Period" (RWP: ~200 BC – 600 AD). Although it is generally thought to be an time interval where global temperatures were relatively high, reconstructions vary remarkably for different regions. Even within a region, reconstructions are not always uniform. For example, the SST in Bermuda Rise studied by Keigwin (1996) shows a temperature decrease between 200 BC and 200 AD. Mangini et al. (2005) and Taricco et al. (2009) also suggest a cold and dry period based on ^{18}O isotopic records of stalagmite from the Central Alps and foraminifera from Central Mediterranean. However, a recent review (Reale and Dirmeyer, 2000) of Mediterranean climate history indicates a gradual warming during the Late Roman Period, and Sicre et al, (2008) reports SST between 0 and 100AD that are similar to those observed during the MWP from the Atlantic, off North Iceland. To obtain more insight into the climatic variability during the RWP there is an urgent need for highly detailed climatic reconstructions.

It has been proved that Mediterranean is a suitable area for paleoclimate studies as it is located between low and mid-latitudes and is influenced by both monsoonal and NAO climate systems. In this study we will present the results of a high temporal resolution study on the climatic and paleoceanographic changes during the "Roman Warm Period" in the Eastern Mediteterranian region (off southern Italy). Excellent time control based on AMS dating and tephra-chronology allows the establishment of three-annual resolution reconstructions. Detailed information about the variability in the organic dinoflagellate cyst associations of piston core DP30PC (39° 50.07' N, 17° 48.05' E, water depth 270 m) allows the reconstruct of short term climatic steered cyclic changes in upper water temperature, productivity and bottom water oxygen concentrations as well as of Italian local river discharge/precipitation signals. Possible mechanisms behind the observed records will be discussed.

References

1 - Keigwin, L. D.1996. The Little Ice Age and Medieval Warm Period in the Sargasso Sea, Science, 274(5292), 1504–1508.
2 - Reale, O. and Dirmeyer, P. 2000. Modeling the effects of vegetation on Mediterranean climate during the Roman classical period. Part I: History and model sensitivity, Global Planet. Change, 25, 163–184.
3 - Sicre, M. A., et al, .2008. Decadal variability of sea surface temperatures off North Iceland over the last 2000 yrs, EPSL., 268, 137–142.
4 - Taricco, C. et al:2009. Two millennia of climate variability in the Central Mediterranean. Clim. Past, 5, 171–181.
5 - Mangini, A., Spötl, C., and Verdes, P.2005. Reconstruction of temperature in the Central Alps during the past 2000 yr from a ^{18}O stalagmite record, EPSL, 235, 741–751.

MULTIPLE SEISMIC STUDIES IN THE MARMARA SEA FOR HIGH RESOLUTION MAPPING OF THE NORTH ANATOLIAN FAULT

G. Çifçi [1], M. S. Steckler [2], C. Sorlien [3], L. Seeber [2], D. Dondurur [1], S. Gürçay [1], J. Diebold [2], S. Okay [1]*, D. Shillington [2], S. D. Akhun [1], D. Timur [4], E. Perinçek [4], C. Imren [4], H. Kurt [4] and E. Demirbag [4]

[1] Dokuz Eylül Üniversitesi-Institute of Marine Sciences and Technology - seda.okay@deu.edu.tr

[2] Lamont-Doherty Earth Observatory-Columbia University

[3] 3. Institute for Crustal Studies, University of California at Santa Barbara

[4] Istanbul Technical University-Geophysical Engineering Departme

Abstract

Fault motion and basin evolution in the Marmara Sea are 4 dimensional. The Sea of Marmara developed along the highly active, right - lateral North Anatolian Fault, which produced devastating historical earthquakes along its 1600 km length. A cruise took place in July 2008 of high-resolution MCS data throughout the Marmara Sea under TAMAM (**T**urkish-**A**merican **MA**rmara **M**ultichannel) Project. Seismic sections across the Western Ridge, a transverse ridge separating the Tekirdag and Central Basins, show folding of strata above a blind thrust. Growth structures show that the eastern anticline of these folds is active and rapid subsidence and tilting in the Marmara Trough are responsible for widespread gravitational collapse.

Keywords: Tectonics, Seismics

The Sea of Marmara developed along the highly active, right -lateral North Anatolian Fault (NAF), which produced devastating historical earthquakes along its 1600 km length. A cruise took place in July 2008 using the *R/V K. Piri Reis* collecting >2700 km of high-resolution MCS data throughout the Marmara Sea under TAMAM (**T**urkish-**A**merican **MA**rmara **M**ultichannel) Project. TAMAM was supported by NSF and used the facilities of Seismic Laboratory at Institute of Marine Sciences and Technology (Fig.1). The seismic source was 45-45 cubic inch GI gun, - fired every 12.5 m and sometimes 18.75 m. The streamer had 72 channels with a group spacing of 6.25 and a – maximum ofset of 55 m. The North Branch of the NAF accounts for most of the current plate motion and is associated with all three main basins in the Marmara Sea. Seismic sections across the Western Ridge, a transverse ridge separating the Tekirdag and Central Basins, show folding of strata above a blind thrust. Growth structures in the sediments show that the eastern anticline of these folds is active and probably propagating eastward above the blind thrust. Some profiles show that rapid subsidence and tilting in the Marmara Trough are responsible for widespread gravitational collapse. One of the major regions of geological interest is the area close to the North Anatolian Fault (NAF) where evidence of gas hydrates and fluid escapes have been observed during previous scientific cruises (Géli, L., et al., 2008). Helium gas, gas hydrate and oil leaks on western high and biogenic gas have been sampled in Çinarcik basin. Most of the gas appears to be focused on the Western and Central Highs and in the Imrali Basin. The near future goal of the demonstration mission project (MARMARA-DM) is to contribute to the establishment of optimized permanent seafloor observatory stations for earthquake monitoring in the Marmara Sea, as part of **E**uropean **S**eas **O**bservatory **Net**work (ESONET) of Excellence Project (6th FrameWork Program of European Union) and includes high-resolution seismic surveys to image the fluid conduits in the upper (1 km) sediment layer.

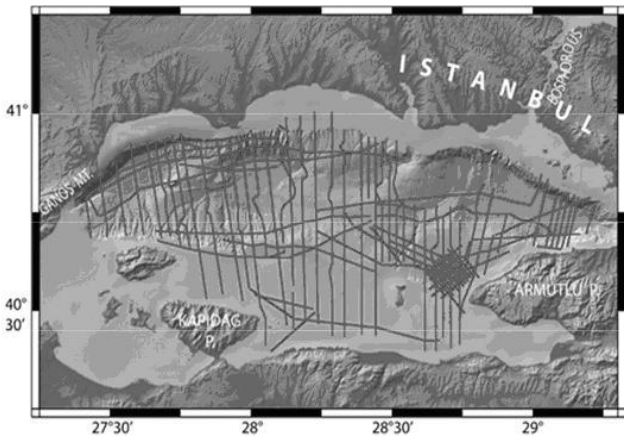


Fig. 1. A cruise took place in July 2008 using the *R/V K. Piri Reis* collecting >2700 km of high-resolution MCS data throughout the Marmara Sea under **TAMAM** (Turkish-American MArmara Multichannel) Project

References

1 - Géli, L., Henry, P., Zitter, T.. Dupré, S., Tryon, M., Çagatay, M. N., de Lépinay, B. Mercier, Le Pichon, X., Sengör, A. M. C., Görür, N., Natalin, B., Uçarkus, G., Özeren, S., Volker, D., Gasperini, L., Burnard, P., Bourlange, S., the Marnaut Scientific, Party, 2008. Gas emissions and active tectonics within the submerged section of the North Anatolian Fault zone in the Sea of Marmara. *Earth and Planetary Science Letters*, 274(1-2): 34-39.

THE MELILLA CARBONATE MOUNDS: DO DEEP-WATER CORAL MOUNDS COUNT ON SEEPING FLUIDS IN THE ALBORAN SEA?

Menchu Comas [1]* and Luis M. Pinheiro [2]
[1] Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Universidad de Granada, 18002, Spain - mcomas@ugr.es
[2] University Of Aveiro, Department Of Geosciences, 3810-193, Aveiro, Portugal

Abstract
A large cluster of Holocene to Present deep-water coral mounds -the Melilla Mound Field (MMF)- occurs in the southeastern margin of the Alboran Sea. High-resolution and multichannel seismic, side-scan swath bathymetry, acoustic sub-bottom profiling, and sampling have investigated the MMF. The mounds are ridge-like buildups 100–250 m wide, 2-6 km long, and 20–60 m (up to 200 m) high above the seabed, which lie in water depths ranging from 230 to 500 m. Sampling proves that mound are largely formed of cold-water corals with a muddy matrix. Seismic profiles across the MMF show that faults exist beneath the mound-ridges, so that mounds nucleation would have influence from fluid venting via fractures that may leak thermogenic gas or cold hydrocarbon seepages in addition to any likely oceanographic control in mound's origin.
Keywords: Alboran Sea, Bio-Accumulation, Deep Waters, Sediments, Seismics

A cluster of Holocene deep-water carbonate mounds -the Melilla Mound Field (MMF)- was discovered in the southeastern margin of the Alboran Sea (Morocco margin) during the MARSIBAL-06 Cruise (R/V BIO Hespérides, 2006) [1]. The carbonate-mound field was revisited and sampling during the TTR-17 Leg 1 survey [2]. The MMF occurs from the upper to the middle slope, with NW-SE trending, on a gentle-dipping margin segment and covers an area of more than 20 km^2. Deep-water carbonate mounds, comparable to those of the MMF, have not been documented before in the Alboran Sea. Swath bathymetry, acoustic sub-bottom profiling, high-resolution MAK-1 side-scan sonar, multichannel seismic, high-resolution seismic, and coring have investigated the MMF Seafloor mounds appear as ridge-like buildups 100–250 m wide, 2-6 km long, and 20–60 m (up to 200 m) high above the seabed; which lie in water depths ranging from 250 to 500 m. They are also surrounded by elongated erosional moats, probably caused by bottom currents on the sea floor, which are 5-10 m deep and 50-100 m wide. Some ridges have no linear but branched shapes. Buried or partly buried mounds, as showed by sub-bottom profiles, are elongated and domed families of buildups (transparent acoustic facies) rooted on highly reflective sedimentary layers and surrounded by dark reflective moats, with dome-size increasing seaward. They grow beneath the upper slope off the shelf break (water depth from 230 m), producing bulges in the seafloor, and give way to seabed mounds with depth. At least three generations of successive mound-growth families are observed. Some ridged-mounds nucleated upon former ones so that buried constructions (columnar appearance in acoustic sections) grow up to 160 m high. The internal architecture of mound-cluster prograding seawards suggests that mounds developed during a period of sea-level drop or slope tilting. Sampling by coring, TV grab and dredging during TTR-17 Leg 1 encountered that mounds are formed of biogenic accumulations made up of corals (*Madrepora occulata, Caryophyllia sp, Desmophyllum sp, Lophelia pertusa)* and other common associated fauna. Colonies of dead *scleratinean* corals and a diverse community dominated by soft corals, sponges and asteroids were observed in TV runs. So that it is proved that mounds from the MMF correspond to modern cold-water carbonate knolls The MMF occurs about 200 km to the east of the Alboran Mud Diapir Province were mud volcanoes, pockmarks fields, seepages (methane) and fluid vents are well documented as controlled by recent or actual tectonics. The geological setting indicates the entire Alboran Basin, which is depleted of Messinian evaporites, is affected by a significant Plio-Quaternary and still active wrench tectonics producing local subsidence and uplifting. Seismic profiles across the MMF show that faults exist beneath the mound ridges, so that we propose and argue that in addition to probable oceanographic control, mounds nucleation may have some influence from fluid venting via fractures that may leak thermogenic gas or cold hydrocarbon seepages. in addition to any likely oceanographic control in mound's origin. Contribution from Projects SAGAS CTM2005-08071-03-01, MARCAL CGL2006-13327-C04-04 and TOPO-IBERIA CSD2006-00041 (Funded by R & D National Plan of the Ministry of Science and Technology and FEDER funding, Spain) and Research Group RNM 215 (Junta de Andalucía).

References
1 - Comas M.C. and Pinheiro L. M., 2008. Discovery of Carbonate Mounds in the Alboran Sea: The Melilla Mound Field. 33 IGC-2008. DVD Abstracts
2 - Comas M. C., Pinheiro L., Ivanov M., and TTR-17 Leg 1 Scientific Party, 2009. Deep-Water Coral Mounds in the Alboran Sea: The Melilla Mound Field Revisited. *In*: Geo-Marine Research on the Mediterranean and European-Atlantic Margins. International Conference and TTR-17 Post-Cruise Meeting of the Training-through-Research Programme. Granada, Spain, 2-5 February 2009. *IOC Workshop Report*, 220: 8-9

SLOPE-TO-BASIN SEDIMENTARY PROCESSES IN TECTONICALLY ACTIVE SETTINGS : A COMPARATIVE ANALYSIS OF THE CALABRIAN AND LIGURIAN MARGIN DURING THE LAST 5MA

M. Coste [1]*, S. Migeon [2], S. Ceramicola [3], J. Mascle [2] and D. Praeg [3]

[1] OGS (Istituto di Oceanografia e di Geofisica Sperimentale) Borgo Grotta Gigante, 42/C - 34010 - Sgonico (TS) - Italy

[2] Université de Nice-Sophia Antipolis, UMR GéoAzur, UNSA-CNRS-UPMC-IRD-OCA, Port de la Darse, 06235 Villefranche/Mer, France

[3] OGS (Istituto di Oceanografia e di Geofisica Sperimentale) Borgo Grotta Gigante, 42/C - 34010 - Sgonico (TS) - Italy / Université de Nice-Sophia Antipolis, UMR GéoAzur, UNSA-CNRS-UPMC-IRD-OCA, Port de la Darse, 06235 Villefranche/Mer, France - mcoste@ogs.trieste.it

Abstract

This study aims to better understand the processes of formation and evolution of six submarine canyons along the western margin of the Ligurian Basin, in relation to the regional geological context and to do a comparative preliminary analysis with the Calabrian Margin.

Keywords: Geomorphology, Continental Slope, Continental Margin, Ligurian Sea, Sediment Transport

Sediment transfer from continental shelves to deep-water basins is an important control on the morphological and architectural evolution of continental margins. Downslope transfer of sediments via processes of erosion and deposition result in the construction of typical features such as submarine canyons. This study aims to better understand the processes of formation and evolution of six submarine canyons along the western margin of the Ligurian Basin, within an offshore area extending from Nice (France) to Imperia (Italy). Processes of slope failure are analyzed within the same zone in order to investigate a wide range of gravity-driven sediment transfer processes.

Analyses of seabed morphology, subsurface structures and present-day sedimentary processes are based respectively on swath bathymetric data, seismic-reflection profiles (24-channel) and side-scan sonar imagery, acquired during the MALISAR 1 and 2 surveys. These data allow an analysis of the main geometric characteristics of the canyons and of failure scars (width, depth, incision shape), and of their internal structures, in order to better understand their origin, construction mechanisms and evolution in relation to the regional geological context. We show that submarine canyons adjust to the general evolution of the margin topography, via processes including regressive erosion and deviation of the thalweg axis. Canyons can therefore be used as markers of deformation of the Ligurian Basin margin, which is an example of a passive margin that has been reactivated in a compressive sense since later Pliocene time. Deformation of the Ligurian Basin increases eastward and basinward, in response to uplift of the Ligurian coast. Thus, canyons in the west are considered as mature canyons, with concave longitudinal profiles, their upper parts characterized by V-shaped thalwegs (in cross-sections), and high slope-gradients, while their lower parts by U-shaped and low slope-gradients. In contrast, canyons in the east present convex longitudinal profiles and V-shaped thalwegs (in cross-sections), with increasing slope-gradients towards their lower parts, and are described as immature canyons that are being readjusted by regressive erosion.

A similar study is in progress for the Ionian continental margin of Calabria , using similar data to undertake a first analysis of slope-to-basin sedimentary processes over Pliocene timescales. This will facilitate a comparative analysis of these two tectonically active margins, the Ligurian Margin (passive margin reactivated in compression) and the Calabrian Margin (active subduction margin).

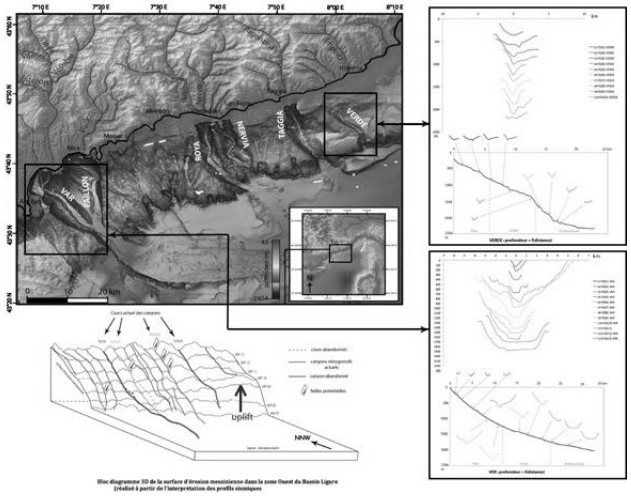


Fig. 1. Bathymetry of the Western Ligurian Margin, longitudinal profiles and cross-sections of thalwegs of the Var canyon and the Verde canyon

References

1 - Béthoux, N., 1992. A closing Ligurian Sea, *Pure and Applied Geophysics*, 139(2): 179-194.

2 - BigotCormier, F., Sage, F., Sosson, M., Déverchère, J., Ferrandini, M., Guennoc, P., Popoff, M., Stéphan, J.F., 2004. Déformations pliocènes de la marge nord-Ligure(France) : les conséquences d'un chevauchement crustal sud-alpin, Bull. Soc. G.ol.Fr., t. 175., n¢X2, p197- 211.

3 - Migeon, S., Mulder, T., Savoye, B. and Sage, F., 2006. The Var turbidite system (Ligurian Sea, northwestern Mediterranean)-morphology, sediment supply, construction of turbidite levee and sediment waves: implication for hydrocarbon reservoirs. *Geo-Marine Letters*, 26: 361-371.

4 - Praeg D., Ceramicola S., Barbieri R., Unnithan V., Wardell N., 2009, Tectonically-driven mud volcanism since the late Pliocene on the Calabrian accretion Prism, central Mediterranean Sea, *Marine and Petroleum Geology*, 26, 1849–1865; doi:10.1016/j.marpetgeo.2009.03.008.

EASTERN MEDITERRANEAN ANAXIMANDER AND NILE MUD EXPULSION STRUCTURES: DEEP ORIGIN FOR FLUIDS AND GASES.

Gert J. De Lange [1]*, Vincent Mastalerz [1] and Anke Daehlmann [1]
[1] Geosciences, Utrecht University, 3584CD, Netherlands - gdelange@geo.uu.nl

Abstract
Mud expulsion structures occur in eastern Mediterranean Passive and Active Margin settings. Active structures have major fluxes of methane and also higher hydrocarbons. The porefluid and hydrocarbon isitopic composition idicate a deep source for the water and for the gases. Variable salinities of the porefluids are encoutered as related to the presence or absence of underlying Messinian evaporites.
Keywords: Active Margins, Passive Margins, Eastern Mediterranean, Mud Volcanoes

In the Eastern Mediterranean not only the Mediterranean Ridge (Äctive Margin") but also the Nile Fan area ("Passive Margin") are characterized by active mud expulsion structures. These structures at Anaximander area and Nile fan have been sampled for the integrated study of fluid and gas systematic, including the potential occurrence of Gas Hydrate (GH). At Anaximander, the active top part of mud volcanoes is usually characterized by fluids of reduced salinities (~10 ‰), whereas in the Nile area, these structures have fluids of near-normal salinity to brine composition (> 300 ‰). The low salinity waters are related to deep dewatering during smectite-illite transition, whereas the high salinities result from dissolution of underlying Messinian evaporites [1]. It seems therefore, that the salinity of the advecting fluids is dramatically different between the two areas, whereas the measured methane concentrations are similar, ranging from 1 to 3 mM for Anaximander and from 1.5 to 3.5 mM for the Nile area. In addition, in both areas but in particular that of the Nile, major expulsions of gas occur into the water column [2,3]. In the Anaximander area low sub-bottomwater temperatures occur associated to GH decomposing during recovery, whereas in particular the Cheops and Chefren mud volcanoes in the Nile area have enhanced salinities & temperatures being 150 ‰ & 57°C at Chefren and > 300 ‰ & 37 / 25°C at Cheops. The latter two mud volcanoes situated inside the large Menes Caldera, 8 km diameter, have a distinct chimney-like brine/mud pit. Inside these muddy brine structures, the liquid mud has been sampled for gas, and for porewater. At both sites, the profiles are rather constant with depth and do not differ between cores and accompanying brine-CTD's. The depth of the brine is approximately 300 meters at Chefren and 10 meters at Cheops, which needs to be compared to a 80 m depth of the Menes Caldera itself. Concurring with the enhanced temperatures, the Si concentration in the cores has higher values at Chefren (500-600 µM) and lower values at Cheops (300 µM). Hydrogensulfide was found in higher concentrations in the central cores of Chefren MV (up to 1.5 mM), and only in minor amount at Cheops. Two camembert-like more shallow structures have also been studied in detail: Isis and Amon mud volcano (MV). IN the central part of both MV's methane has similarly high concentrations af for the earlier mentioned sites, but salinity is below normal for Isis and slightlyl above normal for Amon. It is in particular the high sulphate that is remarkable for the latter, pointing to a gypsym evaporate contribution. This results in the peculiar co-occurrence of high methane and sulphate within these sediments, where only in the topmost interval methane is noticeably being degraded [3] . This work is supported in part by the EUROMARGINS Programme of the European Science Foundation (NWO 855.01.032, MEDIFLUX project) and the EU ANAXIMANDER project (EVK-2001-00123).

References
1 - Mastalerz V. Daehlmann A., De Lange G.J. (2009) Differential aerobic and anaerobic oxidation of hydrocarbon gases discharged at mud volcanoes in the Nile deep-sea fan. Geochimica et Cosmochimica Acta 73 (2009) 3849–3863
2 - DAEHLMANN A. and DE LANGE G.J. (2003) Fluid-sediment interactions at Eastern Mediterranean mud volcanoes: A stable isotope study from ODP Leg160. Earth Planet. Sci. Lett. 212, 377-391.
3 - Mastalerz V. De Lange G.J., Daehlmann A., and Feseker T. (2007) Active venting at the Isis mud volcano, offshore Egypt: Origin and migration of hydrocarbons. Chem. Geol., 246, 87-106.

BASIN-WIDE ISOCHRONOUS SELECTIVE FORMATION AND PRESERVATION OF EASTERN MEDITERRANEAN SAPROPEL S1

G. J. De Lange [1]*, C. Slomp [1], E. Erba [2], C. Corselli [2], M. S. Principato [2], D. Crudeli [2], J. Thomson [3], D. Merconi [3], G. Anastasakis [4], A. Michard [5], A. M. Ferreira [6], J. Sinninghe-Damste [7] and C. Vale [6]

[1] Institute for Earth Sciences, Utrecht, Netherlands - gdelange@geo.uu.nl

[2] Universita degli Studi di Milano, Italy

[3] Southampton Oceanography Centre, United Kingdom

[4] National and Kapodistrian University of Athens, Greece

[5] Laboratoire de Geosciences de l'Environnement, Aix-en-Provence, France

[6] Instituto de Investigacao das Pescas e do Mar, Lisboa, Portugal

[7] NIOZ, Texel, Netherlands

Abstract

Initial deposition and preservation of the most recent sapropel S1 took place basin-wide and iso-chronous. Our basin-wide approach further elucidates that the watercolumn below ~ 1.8 km must have remained predominantly anoxic during sapropel S1 deposition. A marked Mn-rich sediment bed formed during the onset of reventilation at the end of sapropel S1. Its postdepositional preservation is dependent on organic matter and sulphide content and subsequent sedimentation rates.

Keywords: Sediments, Paleoceanography, Deep Sea Processes

Mediterranean marine deposits found on land and at the seafloor, all demonstrate a clear cyclic pattern in their composition that appears related to Milankovitch astronomical variations [1-2]. The clear expression of these climate cycles in Mediterranean deposits in particular is partly related to restricted circulation in this semi-enclosed ocean basin.This restricted circulation results not only in a delicate oxygen balance, but also in a bottomwater formation and residence time that is very sensitive to Global climatic variations in past, present, and future. Variations in riverine fluxes concording with humidity-related climate cycles not only lead to variations in bottom water conditions but also in nutrient fluxes [3]. These variations have resulted in alternating organic-rich (sapropels) and organic-lean (marls) sediment intervals. This astronomical cyclicity serves as a perfect time-marker for Mediterranean Miocene to recent sediments, which permits an unprecedented comparison of samples in identical time-slices but from different locations. Some of these organic-rich units have a high degree of lamination [e.g. 4], thus permitting high-resolution studies, whereas the sedimentary expression of precessional cycles, volcanic ash layers and other time markers permit a high degree of age control. Potentially basin-scale reconstructions are possible for such time-slices, in particular for the most recent S1 period [5]. Such reconstruction may not only involve the oceanographic aspects of this model-ocean, but also the various land-ocean interactions, such as riverine and eolian inputs from various surrounding landmasses [6].

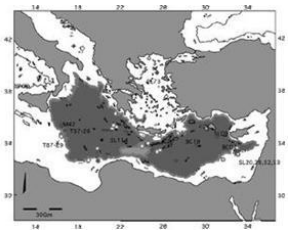


Fig. 1. In dark grey: deep water, thought to have been (nearly) permanently anoxic during sapropel S1 formation (5.7-9.8 ka ^{14}C BP); Analysed core sites are indicated.

As a consequence, climatic variations are accurately recorded not only by giving variations in typical 'marine' signals, but also in typical 'continental' signals. The 'Monsoonal index' is strongly associated with the paleoclimatic conditions in the area around the Eastern Mediterranean, i.e. Sahara/ Africa, Middle East, Southern Europe. This association is clearly present in its sediments, mainly in a ~ 21 kyr precession-controled cycle: during 'humid' climatic periods organic-rich sediment (Sapropel) is deposited containing strong river and marine productivity signals, whereas during 'arid' climatic periods organic-lean sediment is deposited containing high dust input signals. As a consequence of the increased fresh water (monsoon) input between 10.4 – 5.0 14C ky BP, sapropel S1 formed basin-wide synchronously between 9.8 and 5.7 14C ky BP at all water depths greater than a few hundred metres [5]. Another effect of the increased precipitation over evaporation is water-column stratification, and the resulting restricted deep-water ventilation. This has caused predominantly anoxic water column conditions and as a consequence preferential preservation of organic matter has occurred below 1.8 km during 4,000 years of S1 formation (Fig. 1). Several diagenetic features are associated to sapropels, during their formation and during subsequent more oxic environmental conditions [7]. During sapropel formation the downward export of excess sulphide has resulted in an interval of reduced sediment immediately below S1 [8], whereas the post-depositional excess oxygen content has resulted in the downward removal of the topmost S1 interval [e.g. 9]. In addition, the deep-water reventilation thus re-oxygenation event has resulted in a marked MnO2 bed (previously referred to as Marker Bed; [10]). Using the S1 as a case study similar features can be recognized in older sapropel units.

References

1 - Rossignol-Strick, M., Nesteroff, W., Olive, P. & Vergnaud-Grazzini, C. After the deluge Mediterranean stagnation and sapropel formation. *Nature* 295, 105-110 (1982).

2 - Emeis, K.C., Sakamoto, T., Wehausen, R. & Brumsack, H.-J. The sapropel record of the eastern Mediterranean –results of Ocean Drilling Program Leg 160.*Palaeogeog. Palaeoclimatol. Palaeoecol.* 158 371-395 (2000).

3 - Rohling, E.J. Review and new aspects concerning the formation of eastern Mediterranean sapropels. *Mar. Geol.* 122 1-28 (1994).

4 - Jilbert T., De Lange G.J, and Reichart G-J.(2008) Fluid displacive resin embedding of laminated sediments: preserving trace metals for high-resolution paleoclimate investigations. *Limnol. Oceanogr Methods* 6, 2008, 16–22.

5 - De Lange G.J., Thomson J., Reitz A., Slomp C.P., Principato M.S., Erba E., and Corselli C. (2008) Synchronous basin-wide formation and redox-controlled preservation of a Mediterranean sapropel. *Nature Geo* 1, 606-610.

6 - Rutten A., De Lange, G.J. Ziveri P., Thomson J., Van Santvoort P.J.M., Colley S., and Corselli C. (2000) Recent terrestrial and carbonate fluxes in the pelagic eastern Mediterranean ; a comparison between sediment trap and surface sediment. *Palaeogeogr., Palaeoclim., Palaeoecol.* 158, 197-213.

7 - De Lange G.J., Van Santvoort P.J.M., Langeris C., Thomson J., Corselli C., Michard A., Rossignol-Strick M., Paterne M., and Anastasakis G. (1999) Palaeo-environmental variations in eastern mediterranean sediments: a multidisciplinary approach in a prehistoric setting. Progress in Oceanography 44, 369-386.

8 - Passier, H.F., Middelburg, J.J., Van Os, B.J.H. & de Lange, G.J. Diagenetic pyritisation under eastern Mediterranean sapropels caused by downward sulphide diffusion. *Geochim. Cosmochim. Acta* 60**,** 751-763 (1996).

9 - Thomson, J., Mercone, D., de Lange, G.J. & van Santvoort,P.J.M. Review of recent advances in the interpretation of Eastern Mediterranean sapropel S1 from geochemical evidence *Mar. Geol.* 153, 77-89 (1999).

10 - Reitz, A., Thomson, J., De Lange, G.J., Hensen, C. Source and development of large manganese enrichments above eastern Mediterranean sapropel S1. *Paleoceanography*, 21, PA3007, doi:10.1029/2005PA001169 (2006).

THE MONTENEGRO-NORTHERN ALBANIAN CONTINENTAL MARGIN: MORPHOTECTONIC FEATURES IN A SEISMICALLY ACTIVE REGION.

F. Del Bianco [1]*, L. Gasperini [1], G. Bortoluzzi [1], F. Giglio [1], F. D'Oriano [1], A. Polonia [1], M. Ravaioli [1], Z. Kljajic [2] and A. Bulatovic [2]
[1] CNR Ismar Bologna, 40129, Italy - fabrizio.delbianco@bo.ismar.cnr.it
[2] Institute of Marine Biology, 85 330, Kotor, Montenegro

Abstract

During four cruises within the ADRICOSM-STAR project high-resolution CHIRP profiles, morphobathymetric data and bottom samples were collected along the seismically active Montenegro and northern Albanian margin. Preliminary analysis of our data suggest that seismogenic structures are marked at the seafloor by morphological features due to deformation of the sediments and possibly to fluid and gas escape.

Keywords: Adriatic Sea, Continental Margin, Geophysics, Tectonics, Bathymetry

The Montenegro coastal region is characterized by intense seismicity and by the occurrence of large historical earthquakes, such as the Great Dubrovnik Earthquake (M=7, 6 April 1667), the June 13, 1593 event (M=6.5), with epicenter located close to Kotor, and the June 1, 1905 event, with epicentre near Skadar. The last large earthquake affecting the region is the M=7.1 (15 April 1979) whose epicentre was located fifteen kilometers from the Montenegro coast between Bar and Ulcinj (Fig.1). This last event stressed the importance of studying the Montenegro offshore to localize seismogenic features and trying to understand their behaviour in time. The Montenegro offshore and coastal area has been included in the northern segment of the Ionian-Adriatic coastal earthquake belt ([1]). This area constitutes the eastern boundary of the Adria microplate, a block of continental lithosphere presently colliding with the Dinarides chain since the late Miocene ([2], [3]); it constitutes the most external sector of the chain. Along the Adriatic coast of Montenegro, the 200 km-long plate boundary consists of a WNW trending thrust belt (Fig. 1), cut by NS and rarely ENE oriented strike-slip faults which laterally segment the major thrust front ([1], [2], [4]).

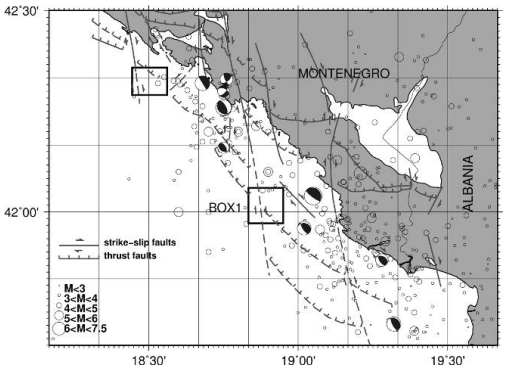


Fig. 1. Structural map of the Montenegro margin ([4] modified). Circles indicate local seismicity and main historical events ([5]). Boxes indicate areas where morphological features possibly related to tectonic deformation were observed

Despite its geological interest and the high seismic hazard, the Montenegro offshore has been poorly investigated in the past, if we exclude extensive multichannel seismic reflection surveys carried out by oil companies, not available to the wider scientific community, and few seismic lines collected during the '90 in the Albania offshore ([3]). During 4 oceanographic cruises, carried out from May 2008 to July 2009 with the Italian CNR research oceanographic ships Urania and Mariagrazia in the frame of ADRICOSM-STAR project (ADRIatic sea integrated COaStal and river basins Management system: Montenegro coaSTal ARea and Bojana river catchment), we collected a set of marine geological and geophysical data offshore Montenegro and northern Albania. Our dataset includes high-resolution seismic reflection profiles and multibeam morphobathymetric data, as well as several sediment samples, gravity cores, grabs, and box corers collected in key areas, selected through interpretation of geophysical data. The sediment accumulation in the coastal area is variable along the margin, probably due to the effect of strong alongshore bottom currents. First results from combined interpretation of seismic profiles and sediment samples suggest that wide areas in the shelf are presently starved, and LGM (Last Glacial Maximum) sedimentary features, such as dunes and sand ridges are present on the seafloor. These features are mostly observed in the bathymetric range 60-120 m and are mainly made of relict coarse sandy material that seems to be cleaned by bottom current reworking.

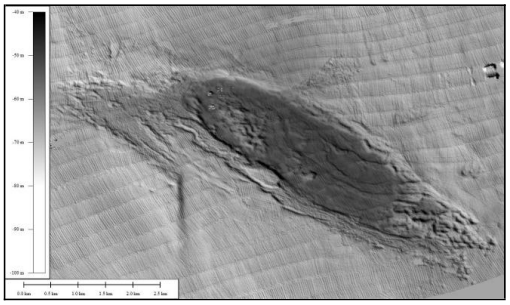


Fig. 2. Morphobathymetric image of compressive deformation along the margin. See figure 1 (box 1) for location

Typical geo-morphological and structural features observed along the margin through integrated analysis of seismic reflection profiles and high resolution bathymetric maps are: 1) hundreds-meter scale bathymetric swells, possibly interpreted as mud volcanoes; 2) elongated, heavily deformed ridges, marking compressive deformation fronts (Fig. 2); 3) rectilinear scarps offsetting the seafloor. All of these features appear aligned with regional tectonic boundaries, described by several authors ([1], [2], [4]) and are thus probably genetically controlled by deep-seated faults. Moreover, a correlation between these features and local seismicity (moderate to large historical earthquakes and recent events) is also observed ([5]). Preliminary analysis of our data suggest that seismogenic structures along the margin, such as thrusts and strike-slip faults, are marked at the seafloor by morphological features due to deformation of the sediments and possibly to fluid and gas escape. This very preliminary results need to be confirmed by further analysis and collection of new data along the margin.

References

1 - Aliaj S., Adams J, Halchuk S., Sulstarova E., Peci V., Muco B. 2004. Probabilistic seismic hazard maps for Albania. 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, August 1-6, 2004, Paper No. 2469.

2 - Aliaj S. 2008. The Albanian Orogen: convergence Zone between Eurasia and the Adria microplate. *In:* N.Pinter, G.Gyula, S.Stein and D.Medak (eds.), The Adria Microplate: GPS Geodesy, Tectonics and Hazards, NATO Science Series, IY, Earth and Environmental Sc., Vol.61, Springer.

3 - Argnani A., Bonazzi C., Evangelisti D., Favali P., Frugoni F., Gasperini M., Ligi M., Marani M., Mele G. 1996. Tettonica dell'Adriatico meridionale. *Mem. Soc. Geol.* It., 51, 227-237.

4 - Oluic M., Cvijanovic D., Prelogovic E. 1982. Some new data on the tectonic activity in the Montenegro coastal region (Yugoslavia) based on the landsat imagery. *Acta Astronautica* v 9, No.1, 27-33.

5 - Pondrelli S., Salimbeni S., Ekstrom G., Morelli A., Gasperini P., Vannucci G., 2006. The Italian CMT dataset from 1977 to the present. *Phys. Earth Planet. Int,* doi: 10.1016/j.pepi.2006.07.008,159/3-4, pp. 286-303.

GEOPHYSICAL SIGNATURE FOR SEEPAGE ACTIVITY AT THE MENES CALDERA: AN EXCEPTIONAL SITE OF BRINE, GAS AND MUD EXPULSIONS IN THE DEEP WATERS OFF NORTH-WESTERN EGYPT

S. Dupré [1], L. Brosolo [2], J. Mascle [2]*, C. Pierre [1], F. Harmegnies [3], V. Mastalerz [4], G. Bayon [3], E. Ducassou [5], G. De Lange [4] and J. P. Foucher [3]

[1] UPMC-LOCEAN, 75252, Paris, France

[2] Géosciences Azur, Observatoire Océanologique, 06235, Villefranche sur Mer, France - mascle@geoazur.obs-vlfr.fr

[3] Département des Géosciences Marines, IFREMER, 29280, Plouzané, France

[4] Utrecht University, 3508 TC Utrecht, Netherlands

[5] Universite Bordeaux 1, 33 405, Talence, France

Abstract

The Nile Deep Sea Fan hosts numerous active fluid escape structures associated with large gas emitting mud volcanoes, authigenic carbonates, pockmarks and briny mud volcanoes. During the Medeco2 expedition (HERMES Program), some of these seeps were investigated with the research vessel Pourquoi pas?. Subbottom profilers and water column imageries were acquired with a CHIRP and an EA600 echosounder. Near bottom geophysical investigations were conducted with the use of the Victor ROV that was equipped with 1) a Reson 7125 multibeam system for high-resolution bathymetry and backscatter seafloor imagery and 2) an OTUS camera for black and white imaging. We present here the geophysical characterization of the large mud volcano Menes caldera complex located in the Western Nile Province.

Keywords: Deep Sea Processes, Eastern Mediterranean, Geophysics, Mud Volcanoes

The Menes Caldera discovered on the foot of the northwestern Egyptian continental slope [1, 2] was surveyed in 2007 in great details with in particular the use of the Victor ROV for near bottom geophysical surveys and in situ samplings and measurements. The dataset previously acquired [1, 2] was completed by geophysical imageries of the sediments, the seabed and the water column.

Extending by 3000 m water depths with a diameter of ~8 km, the Menes Caldera contains several active mud volcanoes. Chephren and Cheops mud volcanoes located in the south and roughly in the centre of the caldera, respectively, are the most spectacular.

The Chephren structure is composed of two craters of 250 to 300 m in diameter each. The northern crater is filled up with muddy brine sediments. Within this brine lake, salinity reaches high values (120 to 145 psu). Gas analysis in the water column revealed high methane concentrations, 0.4 to 5.6 mmol/l. The temperatures within the lake indicate uniform values with depth, reaching ~60°C. In contrast, the southern crater is relatively cold with thermal gradients similar to background values. This crater 10 to 20 metres deep corresponds to a former brine lake that is at present inactive in terms of brine seepage. Running outflows emitted from the northern brine lake are visible all around the mud volcano with the most recent activity located at the northern side. The seepage activity there corresponds to highly unstable seafloor environment. The fauna is mostly restricted within the close periphery of the brine lake. The small and narrow subcircular plateaus that composed the upper part of the crater attracts many crabs and polychaete tubeworms. Within the brine lake, the less unstable areas appear to be characterized by dense accumulation of white filaments that correspond to sulfur associated with arcobater, sulphide oxidizing bacteria (Boetius et al.).

Cheops mud volcano, similarly to Chephren, exhibits high salinity values and methane concentrations (respectively 210 to 240 psu and 2.4 to 3.7 mmol/l). Cheops mud volcano, with an average diameter of ~250m, is composed of a brine lake surrounded by an almost continuous depression ring, covered in some places with recent outflows. This latter probably corresponds to a former edge of the lake. As previously suspected by [2], the inner domain of this mud volcano correlates with an almost flat top where numerous muddy brine pools, decimetre to metre in scale and covered by whitish filaments, were observed at the surface of the lake. An average temperature of ~43°C was recorded from the surface of the lake down to 440m through a very unconsolidated material. The uniformity of the temperature profile with depth clearly supports the occurrence of first order active convection within a mud/brine/fluid conduit.

The newly acquired geophysical dataset and high-resolution seabed photographic images brought more details, in particular, in the seabed morphology and spatial distribution of the seepage activity. The seepage activity is not restricted to the major mud volcanoes. The entire caldera is disturbed by fluids associated in depth with numerous faults and fractures and at the seabed with brine-related features. Acoustic anomalies were detected in the water column using the 38 kHz echosounder of the R/V Pourquoi pas?. An echo contiguous to the seafloor was recorded up to 600 m above the seafloor at the south-western border of the Menes. This acoustic anomaly is interpreted as a gas flare associated with a listric fault in relation with salt tectonics.

References

1 - Loncke, L., Mascle, J., and Fanil Scientific Parties, 2004, Mud volcanoes, gas chimneys, pockmarks and mounds in the Nile deep-sea fan (eastern Mediterranean); geophysical evidences: *Marine and Petroleum Geology*, 21, 669-689.

2 - Huguen, C., Foucher, J.-P., Mascle, J., Ondréas, H., Thouement, M., Gontharet, S., Stadnitskaia, A., Pierre, C., Bayon, G., Loncke, L., Boetius, A., Bouloubassi, I., De Lange, G., Fouquet, Y., Woodside J., M., Dupré, S. and the NAUTINIL Scientific Party, 2009, The Western Nile Margin Fluid seepage features: "in situ" observations of the Menes caldera (NAUTINIL Expedition, 2003). *Marine Geology*, 261, 138-152.

INVESTIGATION OF SEISMO-GEOMORPHOLOGIC FEATURES OF FLOWER ISLANDS FAULT OF THE GULF IZMIR

Can Eytemiz [1]*, Atilla Ulug [1] and Faik Erdeniz Ozel [1]
[1] Dokuz Eylul University Institute of Marine Sciences and Technology, 35340, Izmir, Turkey - can.eytemiz@deu.edu.tr

Abstract
Gulf of Izmir is located within a weakness zone known as Izmir – Balikesir transfer zone which is dominant by strike-slip faults. This zone's last activity has verified by 17-20 October 2005 dated "Gulf of Sigacik Earthquakes". The aim of our study is to investigate the seismo-geomorphologic features of Flower Islands Fault which we consider as a part of this zone.
Keywords: Geophysics, Hydrography, Aegean Sea, Seismics

The relation between gulf's seabed deformations and regional stress fields is known from Ocakoglu ve dig. [1]. Large numbers of strike-slip faults are indicated in the region according to their multi-channel seismic studies in the Gulf of Izmir and Gulf of Kusadasi. The cinematic analysis studies of the Gulf of Izmir and it's environs show a NNE – SSW directed expansion and WNW – ESE directed compression during the Quaternary – Holocene period [2]. The region changes it's shape under the influence of the transtensional tectonic regime in which NE and NW directed faults work together. Approximately N-S directed Flower Islands Fault is a fault which is located in this tectonic system. In this study, multibeam sonar (240 Khz – 480 beams), sub-bottom profiler seismic (3.5 Khz) and magnetometer methods are conducted to determine the fault with it's geomorphologic features (Fig. 1).

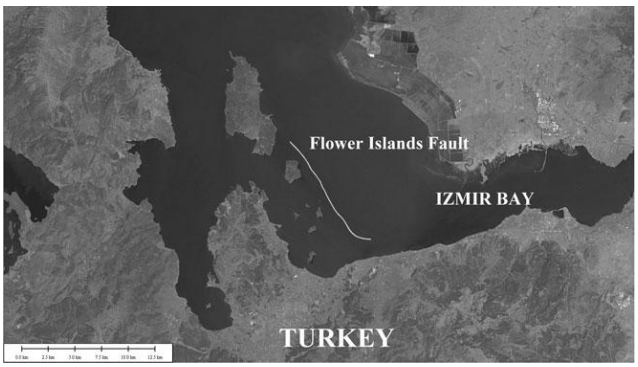


Fig. 1. Seabed surface fracture of the Flower Islands Fault.

Our reviews show a surface fracture of the fault more than 12km and a vertical component more than 2m – 3m. Seismological fault analyses are still being performed for the determination of the fault's other properties.

References
1 - Ocakoglu N., Demirbag E. and Kuscu I., 2004. Neotectonic structures in the area offshore of Alacati, Doganbey and Kusadasi (western Turkey): evidence of strike-slip faulting in the Aegean extensional province. Tectonophysics., 391: 67-83

2 - Sozbilir H., Inci U., Erkul F. and Sumer O., 2003b. An Active Intermitten transform zone accomodating N-S Extension in Western Anatolia and it's relation to the North Anatolian Fault System. International Workshop on the North Anatolian, East Anatolian and Dead Sea Fault Systems: Recent Progress in Tectonics and Paleoseismology and Field Training Course in Paleoseismology, 31 August to 12 September 2003, Ankara.

RELATIONSHIP BETWEEN THE OFFLAP-BREAK LOCATION OF HOLOCENE PROGRADING WEDGES AND WAVE CLIMATE IN SOUTHEASTERN IBERIAN PENINSULA

L. M. Fernández-Salas [1]*, F. J. Lobo [2], F. J. Hernández-Molina [3], P. Bárcenas [4] and V. Díaz-Del-Río [1]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga. - luismi.fernandez@ma.ieo.es
[2] CSIC-Instituto Andaluz de Ciencias de la Tierra, Facultad de Ciencias. Avda. de Fuentenueva s/n, 18002, Granada, Spain.
[3] Dpto. de Geociencias Marinas y O.T., Facultad de Ciencias del Mar. 36310, Vigo, Pontevedra. Spain
[4] Dpto. de Análisis Matemático, Facultad de Ciencias. Campus de Teatinos, s/n. 29080, Málaga, Spain

Abstract

Wave climate exerts a significant influence on the development of Holocene sedimentary prograding wedges. This is demonstrated by the fact that near-bed orbital velocities between 0.10 and 0.14 m/s (threshold for resuspension) occur in the vicinity of the infralittoral prograding wedges (IPW) offlap-breaks during storm-weather conditions, but during medium wave energy conditions in the case of prodeltaic wedges.

Keywords: Alboran Sea, Continental Shelf, Waves, Sediment Transport

Introduction

Holocene prograding wedges are sigmoidal-shaped sedimentary bodies located between the infralittoral zone until the mid continental shelf. They are basically composed both infralittoral and prodeltaic wedges depending if littoral and fluvio-deltaic processes are dominant. The offlap-break determines an important physiographic change in the morphology of these aforementioned wedges and its depth in the infralittoral wedges has been related with the mean level of the storm wave base ([2],[1]).

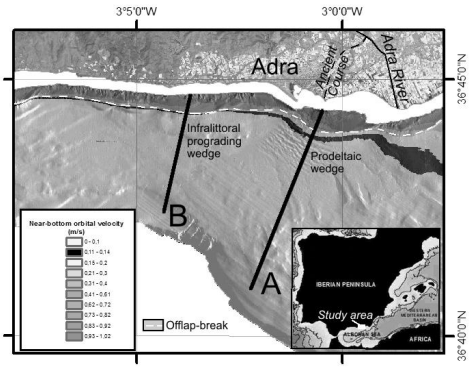


Fig. 1. Near-bed orbital velocity distribution in the study area.

Inner and middle shelf persistenly undergo bed stress exceeding the threshold of sediment motion. The magnitude and frequency of sediment transport , testing its role in the offlap-break point location.events are critical controls on the intensity of physical reworking ([4]). In this contribution, we aim to understand the controlling effect of different wave base levels on the prograding wedges deposits processes and evolution

Methods

Wave-generated near-bed flows are dependent on wave height, H, period, T, wavelength, L, and water depth, h. Near-bed wave orbital velocities (U_b) at the seabed have been calculated by using the following equation ([3]):

$$U_b = H/T \sinh(2\pi h/L)$$

Three energetic wave levels have been used off the coasts of east-southern Iberia (Figure 1), following the classification by Ortega et al. (2004), to calculate U_b: a) High-energy storm conditions, with H=3.5 m and T=8 s (Figure 1); b) Medium-energy, for 50th-percentile of the wave height, with H=1.5 m and T=7s; c) Low-energy fair-weather conditions, with H=0.75 m and T=4s. Water depth values (h) were collected with a 300 kHz Simrad EM3000D multibeam echosounder.

Results and discussion

Near-bed orbital velocities can be used to identify wave-driven sediment transport at a site given representative erosion thresholds. In the study area, those near-bed orbital velocities range between 0 and 1.33 m/s, with maximum values occurring over the topsets (Figure 1 and 2). Bottom wave velocity thresholds for resuspension range between 0.10 and 0.14 m/s, corresponding to bed shear stresses of 0.1-0.2 N/m^2 ([5]). The spatial distribution of this velocity interval correlates with IPW offlap-break location during highest stormy conditions, and with the offlap-break location of prodeltaic wedges during medium-energy conditions. This important difference must be due to the fluvio-deltaic processes dominance in the prograding wedges evolution, which determined differences on sediment supplies and sediment grain sizes.

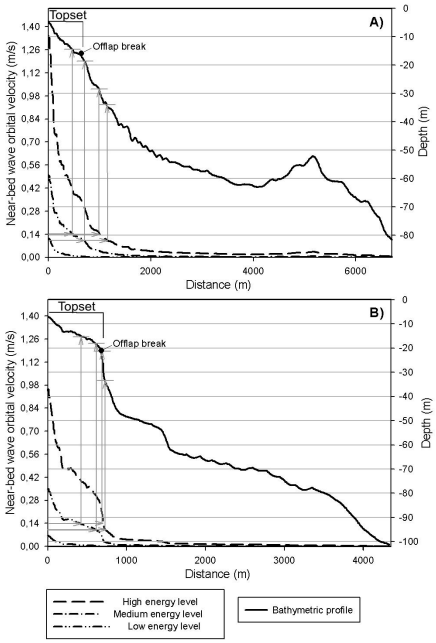


Fig. 2. Near-bed orbital velocity for three different wave conditions and water depth profiles in two locations of the continental shelf. A) Prodeltaic wedge. B) Infralittoral prograding wedge.

Conclusion

Wave energetic conditions have control the Holocene sedimentary prograding wedge morphology and evolution, since they conditioned the offlap-break position in time.

References

1 - Fernández-Salas, L.M., 2008. Los depósitos del Holoceno Superior en la plataforma continental del sur de la Península Ibérica: Caracterización morfológica y estratigráfica. Ph. D. Dissertation, Universidad de Cádiz, pp 277.

2 - Hernández-Molina, F. J., Fernández-Salas, L. M. , Lobo, F.J., Somoza, L., Díaz-del-Río, V. and Alveirinho Dias, J.M., 2000. The infralittoral wedge: a new large-scale progradational sedimentary body in shallow marine environments. Geo-Mar. Lett., **20**: 109-117.

3 - Soulsby, R.L., 1997. Dynamics of Marine Sands. Thomas Telford, London, pp 264.

4 - Wheatcroft, R.A., P.L. Wiberg, C.R. Alexander, S.J. Bentley, D.E. Drake, C.K. Harris and A.S. Ogston, 2007. Post-depositional alteration and preservation of sedimentary strata. In: Nittrouer C. A. et al. (ed.), Continental Margin Sedimentation: From Sediment Transport to Sequence Stratigraphy. Blackwell Publishing, Malden, pp 101-155.

5 - Wiberg, P., 2000. A Perfect Storm: formation and potential for preservation of storm beds on the continental shelf. Oceanog., 13, 3: 93-99.

THE SEASONAL QUANTIFICATION OF GROUNDWATER FLUX INTO THE VENICE LAGOON, ITALY: MASS BALANCE OF RADIUM ISOTOPES AND HYDRODYNAMIC MODEL

C. Ferrarin [1], J. P. Rapaglia [2], L. Zaggia [1]*, G. Manfé [1], G. Umgiesser [1] and M. Ferla [3]

[1] CNR-ISMAR, Istituto di Scienze Marine, Castello, 1364a, 30122 - Venezia, Italy - luca.zaggia@ve.ismar.cnr.it

[2] Christian-Albrechts Universität zu Kiel, Cluster of Excellence, Institute of Geography, Ludewig-Meyn-Str. 14, Kiel D-24098, Germany

[3] ISPRA, Dip. per la Tutela delle Acque interne e Marine, Servizio Laguna di Venezia, San Polo, 50 - 30125, Venezia, Italy

Abstract

An integrated approach, combining the directly measured individual radium contributions and hydrodynamic model results, allowed for the calculation of the mass balance of naturally occurring short-lived Ra isotopes (^{223,224}Ra) in the Venice Lagoon. Hydrodynamic data allows for the calculation of the Ra mass balance in sub-areas of the Venice Lagoon, which are characterized by physically homogeneous properties, instead of the entire lagoon. Both the seasonal and spatial variability of the submarine groundwater discharge (SGD) in the Venice Lagoon were investigated. SGD estimates were correlated with the residence time calculation to better understand spatial and seasonal variation.

Keywords: Circulation Models, Hydrology, Lagoons, Water Transport

Introduction - Methods

Submarine groundwater discharge (SGD) has gained increasing attention, both from the scientific community and coastal resource managers over the last decade [1]. Previous investigations showed that SGD plays an important role in the physical and biological properties of the Venice Lagoon ecosystem [2, 3]. In this study we extended the investigation of SGD to the whole lagoon, through the use of Ra measurements and hydrodynamic modelling. The mass balance for Ra can be expressed by the equation:

$$L_{out} + L_{decay} = L_{in} + L_{river} + L_{diff} + L_{marsh} + L_{desorp} + L_{SGD} \quad (1)$$

which considers the different Ra sources and sinks from the lagoon: water exchanges at the inlets (L_{in}, L_{out}), river discharge (L_{river}), desorption from sediments (L_{desorp}), diffusion from sediments (L_{diff}), percolation of porewater from marshes (L_{marsh}), and SGD (L_{SGD}). Each of these contributions were calculated by using the experimental data obtained from an extensive field and lab campaign (APAT research project "Afflusso di Acque Sotterranee in Laguna di Venezia", 2005-2008) and the application of a hydrodynamical model (SHYFEM), as described by Ferrarin et al. [4]. The lagoon was divided into 4 sub-basins with similar physical characteristics to better characterize SGD using the ^{223,224}Ra mass balance and to allow a more precise estimate of the fluxes from the different sub-basins and through the inlets which connect the lagoon to the Adriatic Sea. Integrating the results of the hydrodynamic model and the point measurements of Ra enabled the calculation of the different sources of Ra for each sub-basin in every season and the volume of the flux associated with SGD. The Ra mass balance calculation utilizes the hydrodynamic information and was effective for both ^{223}Ra and ^{224}Ra. In addition, the application of the hydrodynamic model and a transport model allowed for the calculation of the residence time in each sub-basin per season.

Results

Surface distribution of ^{223,224}Ra showed significant seasonal variation during the six surveys, however, in general, the spatial pattern of distribution within the lagoon was similar with higher activities in the northern and southern sub-basins. In all seasons activities were elevated in the lagoon as compared to river and open Adriatic Sea waters. ^{224}Ra activities were much lower, throughout the lagoon, during the winters of 2007 and 2008 (avg. 43±21 and 55±27 dpm 100 L^{-1} respectively) than during the falls of 2006 and 2007 (avg. 75±52 and 90±33 dpm 100 L^{-1} respectively), the spring of 2007 (avg. 108±41 dpm 100 L^{-1}), and the summer of 2007 (avg.108±65 dpm 100 L^{-1}). ^{223}Ra activities were lower in the winters of 2007 and 2008 (avg. 2.8±1.4 and 3.2±1.6 dpm 100 L^{-1} respectively) than in the falls of 2006 and 2007 (avg. 4.9±2.8 and 6.4±3.1 dpm 100 L^{-1} respectively), the spring of 2007 (avg. 6.3±3.3 dpm 100 L^{-1}) and the summer of 2007 (avg. 5.4±3.6 dpm 100 L^{-1}). The activities of ^{223}Ra in lagoon waters show a similar pattern. Average ^{233,224}Ra activities for the whole lagoon in all seasons are 4.8±3.5 and 79.1±43.6 dpm 100 L^{-1}. The results of the hydrodynamic model show that the residence time of the lagoon has an average value of 7.7±4.6 days and has a marked seasonal variation. The average and standard deviation of the water residence times in the four sub-basins are 8.8±3.6 and 4.9±2.8 days for the two northern sub-basins, 8.3±4.8 and 5.9±3.1 for the central sub-basin and southern sub-basin. More than half of the total Ra entering the lagoon cannot be accounted for by the inputs detailed above and the significant excess of short-lived Ra observed in the Venice Lagoon can, reasonably, be attributed to submarine groundwater discharge. The calculated total input of groundwater into the Venice Lagoon is 43±25 and 40±17×109 L d^{-1} using the ^{223}Ra and ^{224}Ra mass balance respectively. Remarkably, both ^{223}Ra and ^{224}Ra suggest that SGD accounts for 6% by volume of all water flux into the lagoon. Fig. 1 shows the pattern of clear seasonality in the Venice Lagoon. The discharge calculated by both short-lived isotopes is lowest in winter, and higher in spring, summer, and fall. Some divergence occurs between the isotopes in the spring and summer of 2007 which is likely a function of residence time. It is possible that the same forces that determine residence time also drive a re-circulation of seawater through the sediment as there is a strong inverse correlation between residence time calculated using a hydrodynamic model and SGD as calculated by the Ra mass balance method (R2 values are 0.85 and 0.66 for ^{223,224}Ra respectively.

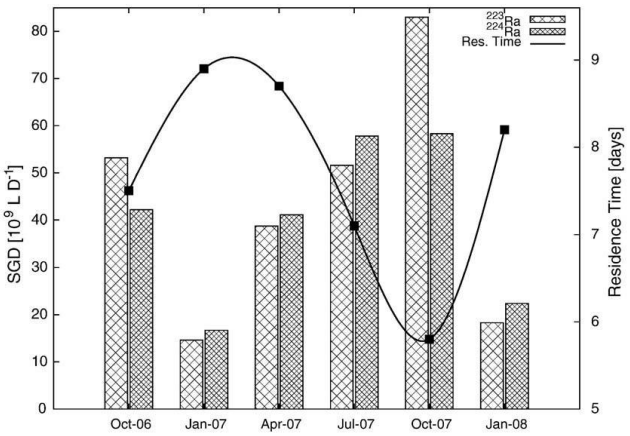


Fig. 1. Seasonal SGD (223Ra and 224Ra) and residence time (dashed line) variation in the Venice Lagoon

References

1 - Burnett, W.C., Taniguchi, M., Oberdorfer, J., 2001. Measurement and significance of the direct discharge of groundwater into the coastal zone. *Journal of Sea Research* 46 (2), 109–116.

2 - Rapaglia, J.P., 2005. Submarine groundwater discharge into Venice Lagoon, Italy. *Estuaries 28* (5), 705–713.

3 - Garcia-Solsona, E., Masquè, P., Garcia-Orellana, J., Rapaglia, J., Beck, A., Cochran, J., Bokuniewicz, H., Zaggia, L., Collavini, F., 2008. Estimating submarine groundwater discharge in the Isola La Cura, northern Venice Lagoon (Italy), by using the radium quartet. *Marine Chemistry* 109 (3–4), 291–306.

4 - Ferrarin, C., Rapaglia, J., Zaggia, L., Umgiesser, G., Zuppi, G.M., 2008. Coincident application of a mass bilance of radium and a hydrodynamic model for the seasonal quantification of groundwater flux into the Venice Lagoon, Italy. *Marine Chemistry*, 112, 179-188.

LONG-TERM SEDIMENT TEMPERATURE OBSERVATION REVEALS RAPID COOLING AFTER A RECENT ERUPTION AT NORTH ALEX MUD VOLCANO ON THE WESTERN NILE DEEP-SEA FAN

Tomas Feseker [1]*
[1] IFM-GEOMAR, 24103, Kiel, Germany - tfeseker@ifm-geomar.de

Abstract
The West Nile Delta Project at IFM-GEOMAR aims to analyze the relationship between deep gas reservoirs and mud volcanoes on the western Nile deep-sea fan. Long-term monitoring of sediment temperature as an indicator of fluid seepage and mud expulsion at North Alex mud volcano revealed that infiltration of cold bottom seawater accelerates the cooling of the sediments after an eruption and points to rapid transitions between extremely active and dormant stages of this mud volcano.
Keywords: Mud Volcanoes, Nile Delta, Temperature, Models

North Alex mud volcano (MV) is located on the upper slope of the western province of the Nile deep-sea fan at a water depth of around 500 m. It is a circular structure with a diameter of less than 2 km and an elevation of nearly 50 m above the surrounding seafloor at its highest point. The central plateau is characterized by gentle slopes towards a steep edge of about 40 m height, which separates the central mud pie from a surrounding moat. Based on a geophysical mapping campaign, North Alex MV was described as a deep-rooted active gas chimney that may have triggered slope destabilization associated with significant northward sediment flows and slumps, following the local slope gradient [1]. Further investigations in 2003 showed a moderate sediment temperature anomaly of around 0.8 °C/m and sporadic gas ebullition at the center [2], indicative of a minor level of activity.

More recently, North Alex MV has been the focus of the West Nile Delta Project at IFM-GEOMAR, aiming to study the relationship between deep gas reservoirs and mud volcanoes on the Nile deep-sea fan. A first detailed assessment of the sediment temperatures in the mud volcano during the P362-2 cruise of R/V Poseidon in February 2008 revealed extremely high temperatures of up to more than 70 °C at around 6 m below the seafloor (mbsf) at the center, corresponding to temperature gradients of more than 10 ° C/m [3]. The focus of the temperature anomaly was found at the highest point and the temperature gradients decreased rapidly towards the flanks of the mud volcano, such that the temperature gradient generally correlated with the morphology. Particularly in the central area, however, the sediment temperature distribution was heterogeneous, which suggested a very recent eruption.

A second assessment of the sediment temperatures at North Alex MV was conducted during the 64PE298 cruise of R/V Pelagia in November 2008 [4]. While the sediment temperatures at the center had remained as high as 9 months before, the outer parts of the plateau had cooled significantly and the lateral extent of the main temperature anomaly had decreased by around 50 percent. Using an ROV, numerous gas seeps were observed in the central area of the mud volcano, where a very rough morphology of the seabed with fresh cracks and superficial faults pointed to recent mud eruptions. During the same cruise, an uncabled seafloor observatory was installed close to the center of North Alex MV. Bottom water temperature and pressure, temperature at the seabed, and sediment temperature down to a depth of 5 mbsf is recorded at an interval of 30 minutes in order to monitor the activity of the mud volcano.

The first data from the observatory was obtained via an acoustic link to the R/V Poseidon during the P388 cruise in July 2009 [5]. Unfortunately, due to a malfunction in the modem software, the time series could not be downloaded completely. However, the currently available sediment temperature data documents clearly that the temperature of the sediments decreased more rapidly than by simple conductive cooling in contact with the relatively cold bottom seawater. The most likely explanation for the accelerated cooling is the infiltration of seawater into the mud volcano sediments. This hypothesis is supported by several concave-upward shaped sediment temperature profiles measured on the central plateau, which also indicate downward flow of porewater. In addition, the time series revealed small temperature fluctuations over time scales of several days to months, suggesting that intermittent pulses of rapid fluid expulsion interrupt the general cooling trend.

References

1 - Loncke, L., Mascle, J., and Fanil Scientific Parties, 2004. Mud volcanoes, gas chimneys, pockmarks and mounds in the Nile deep-sea fan (Eastern Mediterranean): geophysical evidences. *Mar. Pet. Geol.*, 21: 669-689.
2 - Dupré, S., Woodside, J., Foucher, J.-P., de Lange, G., Mascle, J., Boetius, A., Mastalerz, V., Stadnitskaia, A., Ondréas, H., Huguen, C., Harmegnies, F., Gontharet, S., Loncke, L., Deville, E., Niemann, H., Omoregie, E., Roy, K. O.-L., Fiala-Medioni, A., Dählmann, A., Caprais, J.-C., Prinzhofer, A., Sibuet, M., Pierre, C., and Damsté, J. S., 2007. Seafloor geological studies above active gas chimneys off Egypt (Central Nile Deep Sea Fan). *Deep Sea Res.* Part I, 54: 1146-1172.
3 - Feseker, T. (ed.), 2008. FS Poseidon Fahrtbericht / Cruise Report P362-2: West Nile Delta Mud Volcanoes. IFM-GEOMAR Report No. 15, IFM-GEOMAR, Kiel, Germany, 63 pp.
4 - Bialas, J. and Brückmann, W. (eds.), 2009. RV PELAGIA Fahrtbericht / Cruise Report Cruise 64PE298: West Nile Delta Project Cruise - WND-3. IFM-GEOMAR Report No. 27, IFM-GEOMAR, Kiel, Germany, 64 pp.
5 - Bialas, J. and Brückmann, W. (eds.), 2009. RV PELAGIA Fahrtbericht / Cruise Report Cruise P388: West Nile Delta Project Cruise - WND-4. IFM-GEOMAR Report No. 31, IFM-GEOMAR, Kiel, Germany, 65 pp.
6 - Feseker, T., Dählmann, A., Foucher, J.-P., and Harmegnies, F., 2009. In-situ sediment temperature measurements and geochemical porewater data suggest highly dynamic fluid flow at Isis mud volcano, eastern Mediterranean *Sea. Mar. Geol.*, 261:128–137.

TRACE ELEMENT DISTRIBUTION IN SEA WATER AND SEDIMENT PORE WATER FROM THE NOVIGRAD SEA AREA (EASTERN ADRIATIC)

Zeljka Fiket [1]*, Nevenka Mikac [1] and Goran Kniewald [1]
[1] Rudjer Boskovic Institute, Zagreb, 10000, Croatia - zeljka.fiket@irb.hr

Abstract
In order to study water geochemistry, digenetic changes within the sediment and processes at the water/sediment interface, levels of trace elements (As, Ba, Co, Cr, Fe, Li, Mn, Mo, Ni, Rb, Sb, Sr, Ti, U and V) in sea water and sediment pore water from the Novigrad sea area were investigated.
Keywords: Adriatic Sea, Geochemistry, Sediments

Introduction
The Novigrad sea is a small, semi-closed bay located in the central part of the eastern Adriatic coast, about 20 km from Zadar (Figure 1). It is connected to the Adriatic sea in the northwest by Velebit channel and the Karin sea in the southeast. Sedimentation processes in the Novigrad sea are dominantly influenced by small karstic river Zrmanja, which discharges in its eastern part, forming highly stratified estuary [1]. Smaller streams like Bašcica, Draga and Slapaca, as well as water inflow from Karin sea have less pronounced but still important influence on the sedimentation in this basin. The aim of this study was to investigate geochemistry of sea water and sediment of the area and establish possible natural and anthropogenic influences on the trace element levels.

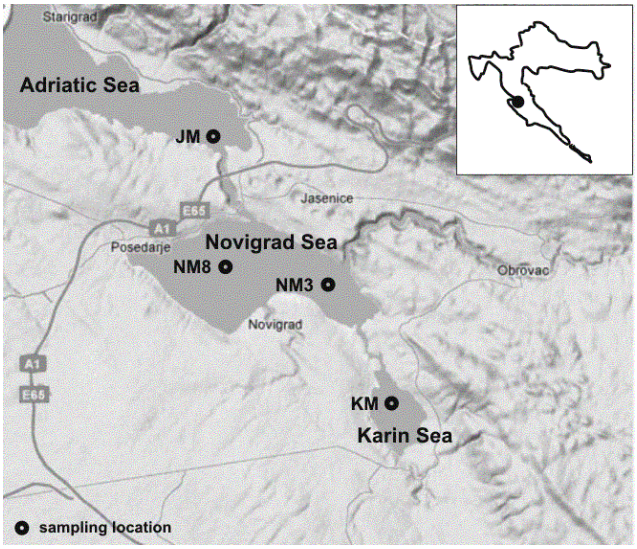


Fig. 1. The map of investigated Novigrad sea area.

Sampling and methods
Samples were taken at four locations, including Novigrad sea, Karin sea and Velebit channel (Figure 1). The sea water was sampled from the surface and bottom layers, whereas pore waters were extracted by centrifugation from sediment cores previously cut into subsamples at 2 cm intervals. Immediately after sampling Eh and pH were measured in sediments, at the same locations. Concentrations of trace elements in sea water and pore water were measured by high resolution inductively coupled plasma mass spectrometry (HR ICP-MS).

Results
The Eh values in the cores became negative almost immediately bellow the sediment-water interface, while the pH values exhibited small variations along the profile. The measured Eh values imply anoxic conditions starting already from the sediment surface. Comparing to the sea water, the pore waters were found to be generally enriched in trace elements. The redox-sensitive elements, Fe and Mn, generally follow the Eh distribution pattern. Co is often associated with Mn oxides which could explain their similar depth profiles (Figure 2). The concentrations of Ba, Mo, Sr and Rb were variable in the upper 8 cm, whereas As, Cr, Li, Ni, Ti, U and V concentrations show variations throughout the profile in all cores. Concentration levels of all analyzed elements in examined surface and bottom water samples were in the range of values reported by Mikac et al. [2] for Krka river estuary and are considered to reflect natural levels. Pore water trace element content is believed to reflect mineralogy of sediments and ongoing diagenetic processes in anoxic environment.

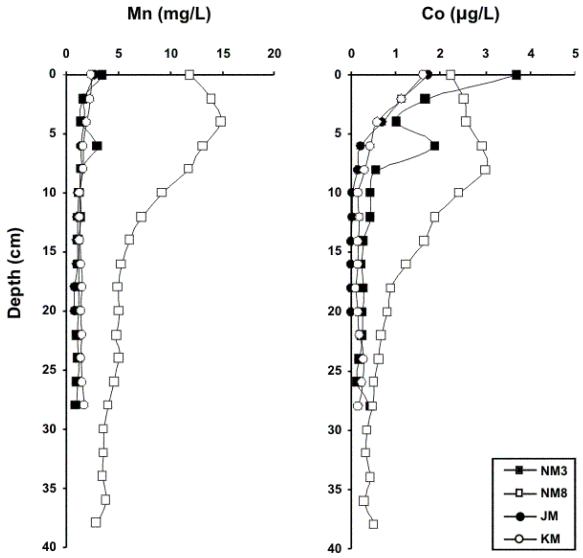


Fig. 2. Vertical distribution of Mn and Co concentrations in the sediment cores from sampling stations NM3, NM8, JM and KM.

References
1 - Vilicic D., Orlic M., Buric Z., Caric M., Kršinic F., Jasprica N., Smircic A. and Gržetic Z., 1999. Patchy distribution of phytoplankton in a highly stratified estuary (the Zrmanja Estuary, October 1998). *Acta Bot. Croat.*, 58: 105–126.
2 - Mikac N., Roje V., Dautovic J., Cukrov N. and Kniewald G., 2007. Distribution of metals and metaloids in sediment and water of the Krka River Estuary. *In*: Marguš D. (ed.), Proceedings of The Krka River and National Park "Krka" Symposium, pp 823-838.

TSUNAMI POTENTIAL IMPACT IN THE LEVANTINE BASIN AT THE ISRAELI COAST BY EARTHQUAKES AND BY SUBMARINE LANDSLIDES USING VERY HIGH RESOLUTION COASTAL GRIDS

Barak Galanti [1], Sergiu Dov Rosen [1]* and Amos Salamon [2]
[1] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa 31080, Israel - rosen@ocean.org.il
[2] Geological Survey Of Israel, Jerusalem, 9550, Israel

Abstract
This paper presents detailed quantification of tsunami impact by application of a very high resolution numerical model studying a number of the worst tsunami feasible scenarios in the eastern Mediterranean and their impact on the Levantine coasts, focusing particularly on the Israeli coast.
Keywords: Bathymetry, Levantine Basin, Models, Waves

Introduction
The study reported here [1] is the first stage in thepreparation of a data bank of potential tsunami scenarios for the Israeli coast, which would enable early tsunami warning upon receipt of tsunami alerts from regional tsunami watch centers being established under the IOC/UNESCO Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas ICG/NEAMTWS) or from local tsunami detection sea level sensors operated by IOLR. Here we present outcomes of a numerical study of the impact of tsunami scenarios for a number of the worst potential events in the eastern Mediterranean's sea, focusing on their impact on the Israeli coast.

Study overview
The simulations were carried out by a state of the art open source numerical model named GeoClaw. It is based on a larger software package called ClawPack that is aimed to solve hyperbolic partial differential equations up to 3 space dimensions, including nonlinear systems of conservation laws. Furthermore, a special feature of the numerical method is its adaptive mesh refinement (AMR), which enables the implementation of meshes with a large range of scales, property that is extremely important when one is interested in solving problems with a multitude of geometric scales, such as for tsunamis. The adaptation of the code and other changes were checked against well accepted benchmark runs.
Two mechanisms for tsunami generation were considered: i) submarine earthquake resulting from the Crete-Helenic arc, and ii) submarine landslides induced by earthquakes at the Dead Sea Transform. Based on older studies [2], the worse cases were chosen accordingly. The movement of the undersea terrain was modeled for the above two mechanisms. Our results were compared with those of older studies and showed agreement for the large scale features. The modeling of the sources in the GeoClaw package is in general a description of the time change of the sea ground. In order to generate these changes, we reconstructed models that describe both earthquakes and landslides. Schematically, the model for the earthquake is taken as a translation of certain quadrilateral region (the moving region) in a linear way. For landslides, a volume in a general form of half elliptic paraboloid is sliding on given chosen track and velocity profile (depends on time). Significant progress has been made by implementing high resolution digital bathymetric and topographic data. The nearshore (shallower than 500m) bathymetry and the topographic data at the coast and river estuaries are on a grid of about 5m cell size.

Results
Maps for maximum inundation, maximum set down, maximum wave height and various time snapshots are produced. The maps for inundation and set down were generated by supplementary Matlab codes which were developed by the first author. Because the solution is found on an adaptive grid (that is also time dependent), one has to interpolate it on a uniform grid for the various snapshots in order to create maximum or minimum maps. For the maximum wave height we introduced for the GeoClaw package a list of sea level gauges located at the lines of zero sea level. From the raw output of a run, we filter out time intervals where the grid is coarse and the information is inaccurate. Next step is to write the maximum of the waves for each gauge point. Example of an inundation map at Haifa bay coast is shown in Fig.1 for the case of an 8.3 earthquake off the eastside of Crete.

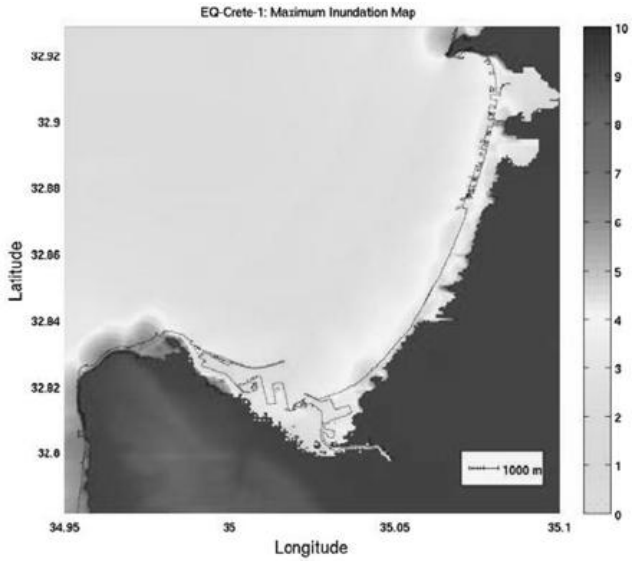


Fig. 1. Example of a maximum inundation map at the Haifa Bay induced by a 8.3 magnitude earthquake off SE Crete.

In order to understand the generation, evolution and dispersion of the tsunami waves, animations were produced. They enable observing complex wave refraction, wave reflection and wave-wave interactions, and the corresponding forcing on the nearshore and coastal structures, cliff, beach erosion, etc.
The presentation will show results of computed flow velocities, flow flux and momentum at various positions and times, where structures such as breakwaters, coastal cliff and other structures are located, as well as the extreme forces assessed for these locations.

References
1 - Galanti, B., Rosen, D.S., and Salamon, A., 2009. Tsunami models adaptation and various scenarios simulations to aid early tsunami warning for Israel, IOLR Report H45/2009, *GSI Report* , TR-GSI/23/2009, September 2009.
2 - Thio, H. K., 2008.Tsunami Hazard in Israel, URS Corporation, Prepared for Geological Survey of Israel.

WATER COLUMN REDOX CONDITIONS DURING SAPROPEL FORMATION; COMPARISON BETWEEN SEDIMENTARY RECORD RECENT ANALOGUES

D. Gallego Torres [1]*, G. J. De Lange [1], F. Martinez Ruiz [2], O. Romero [2], A. Paytan [3], M. Böttcher [4], F. Guichard [5], F. J. Jimenez Espejo [2], V. Nieto Moreno [2], M. Rodrigo Gamiz [6], G. Leriscolais [7] and M. Ortega Huertas [8]

[1] Marine Geochemistry and Chemical Oceanography - Geosciences, Utrecht University - d.gallego@geo.uu.nl

[2] IACT (CSIC-UGR)

[3] Earth and Marine Science Dept. U.C. Santa Cruz (California)

[4] Institute for Baltic Sea Research (IOW) Warnemuende

[5] Laboratoire des Science du Climat et de l'Enviroment. SCE

[6] IACT (CSIC-UGR)

[7] IFREMER Jean-Jacques Rousseau 92138

[8] Departamento de Mineralogia y Petrologia, Universidad de Granada

Abstract

Redox sensitive metals enrichment has been used for the reconstruction of deep water ventilation in the Eastern Mediterranean. We compare fixation of Mo and U on the Black Sea, the present day largest anoxic basin, and sapropels from different periods to elucidate formation conditions based on the recent analogues. Most sapropels present preferential Mo enrichment, attributed to different degrees of water column anoxia and primary productivity. Some layers present Mo:U ratio similar to present day seawater, suggesting anoxic bottom water and constant turnover. Basin stagnation comparable to the Black Sea is only punctually observed in the Mediterranean for the most intense sapropel events.

Keywords: Anoxia, Black Sea, Sapropel

Redox conditions of the water column and circulation in the Eastern Mediterranean during sapropel formation has been extensively discussed [e.g., 1, 2, 3], yet stagnation is still under debate [1, 2]. Using ICP-MS geochemical data, we compare the behaviour redox sensitive elements on Mediterrranean sapropels spanning from 2Ma to recent, from 4 ODP sites, and sediments from a cores in the Black Sea and data from [4]. The co-variation between Mo and U in the sediment depends on sea water chemistry, water column circulation, and shuttle transport adsorbed to organic matter, [4]. The rate of turnover and different fixation process for Mo and U must also have an effect.

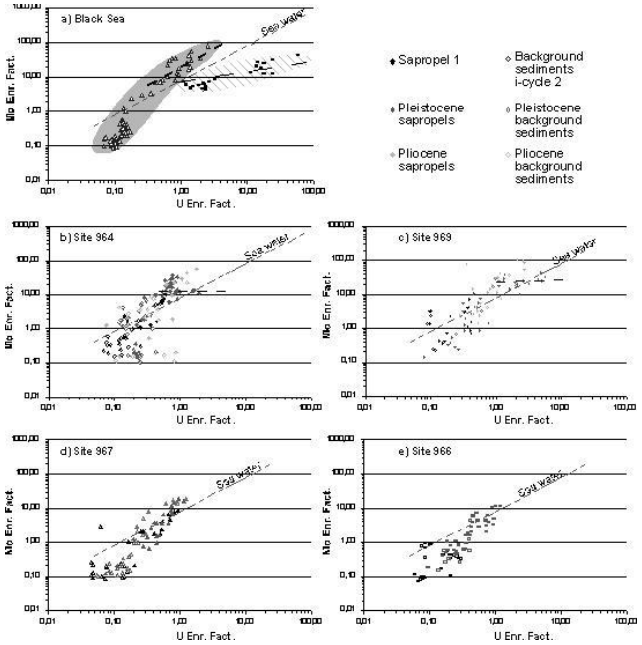


Fig. 1. Mo:U variations (in Enrichment Factors) for Black Sea (a) and Eastern Mediterranean (b-e) sediments. Sea water line marks average Mo:U ratio on sea water (7,8 aprox.). Shading on 1-a distinguish platform (solid grey) and basin (stripes) sediments. Data from the deep basin are from [4].

Black Sea sediments show two trends (Fig.1-a): Samples from the platform (grey shading) are either slightly enriched only in U or following the trend of sea water Mo:U. Fixation of U begins earlier than Mo, and occurs by diffusion into the sediment, whereas Mo can be scavenged from the water column. These evidences indicate a variable chemocline and a constant input of both elements so that none is depleted in the waters. Recent sediments from the deep basin (stripes) follow the same sea water trend, whereas the last sapropel shows relatively constant Mo concentration and progressive U enrichment. This was interpreted [4] as the result of stable stagnant condition that depleted Mo from the upper water layers. A similar representation on Mediterranean sapropels samples shows similar trends. A cloud of background sediments are slightly enriched in U under sub-oxic conditions. Only when the redoxcline shifts upwards into the water column Mo starts to be fixed. Where deepwater circulation allows U and Mo input, a steady state is reached and Mo:U runs parallel to the sea water line. This is the case for S1 at sites 964 and 967 (Fig.1-b and 1-d) and Pleistocene sapropels at 966 (Fig 1-e). Most Plio- Pleistocene levels are preferentially enriched in Mo on sites 964 and 969, which may imply restricted bottom water circulation and thus limited U fixation. However, intermediate water circulation and Atlantic input was not restricted so Mo was continuously scavenged from the anoxic water column, favoured by organic matter shuttle, [4]. A situation similar to the Black Sea sapropel, with a stable shallow chemocline and long term stagnation, is only inferred locally for S5 and S7 at sites 969 and 964 (Fig. 1-b and 1-c, discontinuous black line).

References

1 - Nijenhuis, I.A., Brumsack, H.J., De Lange, G.J., The trace element budget of the eastern Mediterranean during Pliocene sapropel formation, 1998. *Proce. ODP: Scien. Res.* 160: 199-206.

2 - Casford, J.S.L., Rohling, E.J., Abu-Zied, R.H., Fontanier, C., Jorissen, F.J., Leng, M.J., Schmiedl, G., Thomson, J., A dynamic concept for eastern Mediterranean circulation and oxygenation during sapropel formation, 2003. *Palaeog, Palaeoclim, Palaeoec.* 190: 103-119.

3 - De Lange G.J., Thomson J., Reitz A., Slomp C.P., Principato M.S., Erba E., and Corselli C. (2008) Synchronous basin-wide formation and redox-controlled preservation of a Mediterranean sapropel. Nature Geo 1, 606-610.

4 - Algeo, T.J., Tribovillard, N., Environmental analysis of paleoceanographic systems based on molybdenum-uranium covariation, 2009. *Chem.Geol.*

THE LEGNAGNONE SECTION (NORTHERN APENNINES): HIGH-RESOLUTION PALAEOENVIRONMENTAL EVOLUTION TOWARDS THE ONSET OF THE MESSINIAN SALINITY CRISIS.

R. Gennari [1]*, V. Manzi [2], L. Angeletti [3], A. Bertini [4], A. Ceregato [3], C. Faranda [5], E. Gliozzi [5], S. Lugli [6], E. Menichetti [4], M. Roveri [2] and M. Taviani [3]

[1] University of Torino, via Valperga Caluso, 35, 10123 Torino, Italy - rgennari@unito.it
[2] University of Parma, V.le G.P. Usberti 157/A, 43100 Parma, Italy
[3] ISMAR-CNR, Via Gobetti 101, 40129 Bologna, Italy
[4] University of Firenze, Via La Pira 4, 50121 Firenze, italy
[5] University of Roma Tre, Largo S.Leonardo Murialdo, 00146 Roma, Italy
[6] University of Modena e Reggio Emilia, Piazza S. Eufemia 19, 41100 Modena, Italy

Abstract

An integrated study is presented on the lower Messinian, pre-/syn-evaporitic Legnagnone section, located in the Northern Apennine. The study of ostracodes, foraminifers, benthonic macrofossils and pollen associations, together with magnetostratigraphic and foraminiferal biostratigraphic data, allow reconstructing a chronostratigraphic framed paleoenvironmental evolution during the uppermost phase leading to the Messinian salinity crisis and an high resolution stratigraphy of the pre-/syn-evaporitic transition.

Keywords: Messinian, Paleoceanography, Stratigraphy, Evaporites

An integrated approach to the study of the pre-evaporitic sediments in the Mediterranean basin [1] permitted to define a precise time frame of the evolutionary steps towards the MSC (Messinian salinity crisis). Unfortunately, these studies are often carried out in sections lacking primary gypsum (PLG [2]); conversely, they record the deposition of clastic evaporites, both sulphates and carbonates (RLG and Calcare di Base, [2]). Due to these problematic, comprehensive palaeoceanographic reconstructions of the evolution towards the MSC are related to different geological settings. An integrated study of the Legnagnone section (Northern Apennines) was carried out to reconstruct the chronology and palaeoenvironmental evolution of the latest pre-evaporitic events preceding the MSC onset in a marginal area.

The Legnagnone section is located in the Northern Apennines chain. It rests unconformably on Miocene calcarenites and it shows a fining upward trend from deltaic conglomerates and sandstones to marls with limestone intercalations. At the top of the prevalently marly portion of the section, two limestone/organic-rich shale couplets are present just below the first gypsum bed that is up to 10 m thick. Based on facies and stacking pattern characteristics of PLG evaporites in the western Mediterranean [3], the two basal cycles are here missing. Thus the first local gypsum bed can be correlated with the third PLG cycle. Biomagnetostratigraphic data allow to correlate the Legnagnone section with the Molinos-Perales section [4] and thus with astronomical curves. The presence of two *Turborotalita multiloba* influxes, an influx of *Globorotalia scitula*, several influxes of planktonic foraminifera, the coiling ratio of Neogloboquadrinids, and the Gilbert chron base indicate that the Legnagnone section is comprised between ca. 6.15 Ma and 5.9 Ma.

On the basis of benthonic macrofossils, foraminifers and ostracods, three distinct intervals can be recognised, depicting a palaeoenvironmental evolution from infralittoral well-oxygenated domain (up to ca. 6.13 Ma) to upper circalittoral-upper bathyal settings (from 6.13 to 6.03 Ma) and back again to infralittoral depths (from 6.03 Ma up to the MSC onset), both characterized by dysoxic bottom water.

The high percentage of reworked palynomorphs, especially dinocysts, makes unreliable the climatic value of palynological data from the base (54 m) up to 35 m (ca. 6.13 Ma). On the contrary the quite rich pollen assemblages in the upper part of the section, dominated by arboreal taxa (*Taxodium* type, *Engelhardia, Quercus*, *Ulmus*, *Juglans*), testify for a prevalent humid and warm climate.

Concluding, the proposed age of 5.96 Ma [5] for the onset of the MSC is marked by the disappearance of benthonic foraminifers and ostracods, preceded by the disappearance of planktonic foraminifers. However, data indicate that the deposition of sulphates is here delayed of at least two cycles. The lack of several gypsum cycles, replaced by laminated limestone, at the base of PLG deposits is a common features observed also at Sorbas basin and in Piedmont [6] casting a new light on the onset of the MSC.

References

1 - Kouwenhoven T.J., Hilgen F.J., van der Zwaan G.J. 2003. Late Tortonian-early Messinian stepwise disruption of the Mediterranean-Atlantic connections: constraints from benthic foraminiferal and geochemical data. Palaeogeography, Palaeoclimatology, Palaeoecology, 198 (3-4), 303-319.

2 - Roveri M., Lugli S., Manzi V., and Schreiber B.C., 2008. The shallow- to deep-water record of the Messinian salinity crisis: new insights from Sicily, Calabria and Apennine basins. In: (Briand F., Ed.) CIESM 2008. The Messinian Salinity Crisis mega-deposits to microbiology – A consensus report. CIESM Workshop Monographs, 33: 73-82.

3 - Lugli S., Manzi V. and Roveri M. 2008. New facies interpretations of the Messinian evaporites in the Mediterranean. In: (Briand F., Ed.) CIESM 2008. The Messinian Salinity Crisis mega-deposits to microbiology – A consensus report. CIESM Workshop Monographs, 33: 73-82.

4 - Sierro F.J., Hilgen F.J., Krijgsman W., Flores J.A. 2001. The Abad composite (SE Spain): a Messinian reference section for the Mediterranean and the APTS. Palaeogeography, Palaeoclimatology, Palaeoecology, 168 (1-2), 141-169.

5 - Krijgsman W., Hilgen F.J., Raffi I., Sierro F.J., Wilson D.S. 1999. Chronology, causes, progression of the Messinian salinity crisis. Nature, 400 (6745), 652-655.

6 - Lozar F., Bernardi E., Violanti D., Dela Pierre F., Gennari R., Clari P., Cavagna S., Irace A., Lanza R. 2009. Abstract Volume. 13th Congress RCMNS - 2nd - 6th September 2009, Naples (Italy), 381 - 383.

GEOCHEMICAL COMPOSITION OF RECENT SEDIMENT FROM THE SW ADRIATIC SEA AND THE GULF OF TARANTO (S. ITALY) COMPARED WITH THAT OF THE LAST 400 YEARS FOR ONE SITE

Marie-Louise Goudeau [1]*, Shauna Ní Fhlaithearta [1], Brice Robert [1] and Gerrit Jan De Lange [1]
[1] Utrecht University, 3508 TC Utrecht, Netherlands - m-l.goudeau@geo.uu.nl

Abstract

Previous studies from the Gallipoli shelf area indicate continuous sedimentation and high accumulation rates with low disturbance from bioturbation ([1]) permitting high resolution paleoclimate investigations. In this study major and trace elemental composition bulk organic Carbon and Nitrogen, $\delta^{13}C$ and $\delta^{15}N$ from a multi core (NU04MC) from the Gallipoli shelf is presented. These data is used for a paleoclimate reconstruction using results from 47 surface sediments from the area (Gulf of Taranto and SW Adriatic). Preliminary results indicate a strong anthropogenic influence in the last 100 years.

Keywords: Geochemistry, Eastern Mediterranean, Global Change, Paleoceanography

To improve our understanding of causes and consequence of climate and environmental change on decadal to millennial time scales more comprehension is needed on the underlying processes. The Mediterranean lies between low and mid-latitudes and is influenced by both the monsoonal and NAO climate systems making it a key area for paleoclimatic investigations. Continuous, high resolution sedimentary paleo climatic archives permit us to study in sufficient resolution the required time scale. Previous studies from the Gallipoli shelf area (39N46;17E54) indicate continuous sedimentation and high accumulation rates with low disturbance from bioturbation (e.g[1]) permitting high resolution investigations. Carbonate contents, thermolumuniscense, oxygen and carbonate isotopes ([2]) and sea surface temperatures ([3]) all display compositional cycles at frequencies known from solar cycles. The origin and processes related to these variations, however, remain unclear. Therefore, a study is presented here in which recent surface sediments elemental composition from the area are compared and calibrated with recent environmental factors. These results can then be used for a paleoclimatic reconstruction of the last few hundred years using multicore NU-04-MC . For this study the first centimeter of 47 multicores has been sampled (Fig 1.)The multicores are from the area and recovered during the Cappuccino cruise ([4]). These samples have previously been analysed for their foraminiferal isotope composition and Dinoflagellates ([5]). In addition, these samples were analyzed for their total inorganic geochemistry using total destruction and ICP-OES. These data and Bulk organic carbon have been correlated with local environmental variables such as Primary Productivity, Temperature, Oxygen levels and Salinity. Preliminary results show a decreasing trend along the surface sediment transect (Fig 1.) for some elements (e.g. Ba/Al, Cr/Al) indicating them as an indirect proxy for the amount of Adriatic Surface water. Furthermore correlations were found within a range of cores between oxygen penetration levels and redox elements. Bulk organic Carbon and Nitrogen content showed correlations with satellite-derived chlorophyll-a concentrations in different seasons. Furthermore a multicore was retrieved from the area (NU04-MC) which contains finely laminated sediments. Preliminary dating resulted in an estimated age of 400 years for the 380mm core depth. Every 2.5 mm was sampled and analyzed. Correlations found for the surface sediments are used to explain the variability within the core. First results of the core NU-04-MC show increasing trends of some elements know as anthropogenic indicators together with an increase in Ba/Al ratios (Fig 2.) from a depth of 100 mm towards the recent. Increased Ba/Al ratio's can be indicative for an increase of primary productivity but could also indicate a different source for clay minerals [6]). The timing of the increase in a variety of elements including Ba, however, suggests an anthropogenic origin. This work is supported by the EUROCORES/EUROMARC Program of the European Science Foundation (NWO.817.01.002 MOCCHA project).

References

1 - Cini Castagnoli, G. ;Bonino, G.;Taricco, C. and Bernasconi,S.M.,2002

2 - Cini Castagnoli, G.; Bernasconi, S.M.; Bonino, G.;Della Monica, P. and Taricco,C,1996. *Adv.Space Res.* Vol. 24, No.2, pp 233-236

3 - Versteegh, G.J.M.; de Leeuw,J.W.;Taricco,C and Romero,A.,2007. *Geochem.,Geophys. and Geosys.* Vol.8,No 9

4 - Zonneveld, K. and cruise participants,2006.Berichte, Fachbereich Geowissenschaften, Universität Bremen, No. 268, 61 pages. Bremen, 2008

5 - Zonneveld,K.A.F.; Chen,L.; Möbios,J. and Mahmoud,M.S,in press. *J.of Sea Res*

6 - Reitz,A., Pfeifer,K., De Lange,G.J., and KLUMP,J.,2004. *Mar. Geol.Vol.*204, 289-300.

A UNIFYING BIOGEOCHEMICAL MECHANISM FOR SHALLOW GYPSUM VS. DEEP DOLOMITE FORMATION DURING THE MESSINIAN SALINITY CRISIS

Marie-Louise Goudeau [1]*, Gerrit Jan De Lange [1] and Wout Krijgsman [1]
[1] Utrecht University - m-l.goudeau@geo.uu.nl

Abstract

The Messinian Salinity Crisis (MSC) is an event ~ 5.9 Ma ago that resulted in deposition of 0.3-3 km thick evaporites at the Mediterranean seafloor (1-3). Controversy existed on the formation mode,but recently a consensus was reached on several aspects (3).The latter has also clarified remaining issues, such as for the observed shallow gypsum versus deep dolostone deposits (3-5).A recently proposed scenario for the Lower Gypsum units of the MSC infers that primary gypsum only formed in silled marginal basins while dolostones are found at deeper settings. We agree but reject the suggested coincidental presence of similar sills for all marginal basins. Alternatively, we present here a unifying mechanism in which gypsum formation occurs at all shallow water depths but its preservation is mostly limited to shallow sedimentary settings.

Keywords: Messinian, Evaporites

The onset of the Messinian Salinity Crisis is marked by the deposition of gypsum-sapropel alternations (Lower Gypsum unit). Increasing evidence has recently been put forward to show that this gypsum precipitation only occurred at marginal settings, while non-evaporitic rocks have been reported from deeper settings (5-7). The difference in sedimentary environment between marginal and deep Mediterranean settings is only tentatively explained by physical properties like tectonic restriction and/or sea level lowering, for which there is no solid evidence. The chemical processes of gypsum formation during the Messinian salinity crisis, however, are poorly understood and commonly neglected. These may, however, explain that different MSC deposits formed in shallow versus deep environments without the necessity of exceptional physical boundary conditions. For this we have to consider the following processes that are important:

a. Water column stratification due to continuing (but episodic?) inflow of oceanic water and enhanced evaporation thus enhanced salinity of Mediterranean water
b. Organic Matter (OM) debris fluxes settling into the deep waters and being decomposed through oxygen and sulphate
c. Gypsum precipitation is controlled by the product of Ca^{2+} and SO_4^{2-} concentrations

Gypsum precipitation in evaporating seawater takes place at 3-7 times concentrated seawater (8 and refs therein); seawater is always largely oversaturated relative to dolomite but its formation is thought to be inhibited by the presence of dissolved sulphate (9). Thus the conditions for formation of gypsum exclude those for the formation of dolomite and vice versa. Another process that links the saturation states of gypsum and dolomite is that of OM degradation by sulphate reduction. In stagnant deep water oxygen is rapidly depleted through OM degradation, then sulphate becomes the main oxidant for OM mineralization, thus reducing the deep-water sulphate content. In the latter process also considerable amounts of dissolved carbonate are formed. Implicitly this means that low-sulphate conditions (as anticipated for the MSC deep waters), i.e. unfavorable conditions for gypsum formation, always coincide with anoxic, i.e. oxygen-free conditions, although there is no direct relationship between the two. the Messinian Mediterranean would have been characterized by a reasonably well-mixed upper water mass ('shallow waters'), and a strongly stratified lower 'deep-water mass'. The MSC stratification with deep concentrated brines, is very stable, and can only be replaced by an even higher salinity water mass. As a result, continued evaporation and water replacement leads to (episodically) enhanced Ca and SO4 concentrations in the shallow waters, thus potentially to gypsum precipitation. Decreasing sulphate and concomitantly increasing dissolved carbonate in the deep waters limit gypsum preservation and permit dolomite formation to occur. Ultimately, it is the balance between OM-fluxes (primary productivity) and sulphate supply to the deep-water (ventilation, settling gypsum fluxes) that determine the environmental deep-water conditions, thus formation rate of dolomite. On the basis of this unifying mechanism, we have shown that gypsum precipitation in shallow water depths and dolomite formation in deep water settings during the early phase of the MSC in the Mediterranean is not incompatible. As a consequence one would expect a bath tub rim of gypsum at all shallow depths but gyupsum appears mainly at silled marginal basins. However, a thick package of heavy gypsum on top of more liquid mud in a marginal/slope setting is highly unstable, thus any physical disturbance such as tectonic activity or sealevel change, would easily lead to downslope transport of such marginal gypsum deposits. The absence of gypsum and the presence of erosional unconformities at the sill-less Mediterranean passive margins concord to such removal mechanism. In addition, large-scale resedimentation of gypsum has also been found for deep Messinian settings in the Northern Apennines and Sicily. Only at those marginal settings that were silled, the marginal gypsum deposits have been preserved (3-7,10).

References

1 - Hsü K. J., Ryan, W. B. F. & Cita, M. B. Late Miocene desiccation of the Mediterranean. *Nature* 242, 240-244 1973.
2 - Krijgsman, W., Hilgen, F. J., Raffi, I., Sierro, F. J. & Wilson, D. S. Chronology, 1999.Causes and progression of the Messinian salinity crisis. *Nature* 400, 652-655
3 - CIESM. The Messinian Salinity Crisis from mega-deposits to microbiology – *A consensus report* (ed. Briand, F.) (Monaco, 2008).
4 - Roveri, M. & Manzi, V. 2006.The Messinian salinity crisis: Looking for a new paradigm? *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 238, 386-398
5 - Roveri, M., Lugli, S., Manzi, V. & Schreiber, B. C. 2008.The Messinian Sicilian stratigraphy revisited: new insights for the Messinian salinity crisis. *Terra Nova* 20, 483-488.
6 - Lofi, J. et al. 2005. Erosional processes and paleo-environmental changes in the Western Gulf of Lions (SW France) during the Messinian Salinity Crisis. *Mar. Geol.* 217, 1-30.
7 - Manzi, V. et al. 2007. The deep-water counterpart of the Messinian Lower Evaporites in the Apennine foredeep: The Fanantello section (Northern Apennines, Italy). *Palaeogeogr. Palaeoclimatol. Palaeoecol.* 251, 470-499.
8 - De Lange, G. J. et al. 1990.Sulphate-related equilibria in the hypersaline brines of the Tyro and Bannock Basins, eastern Mediterranean. *Marine Chemistry* 31, 89-112.
9 - Baker, P. A. & Kastner, M. 1981.Constraints on the formation of sedimentary dolomite. *Science* 213, 214-216.
10 - Rouchy, J.-M. & Caruso, A. 2006.The Messinian salinity crisis in the Mediterranean basin: A reassessment of the data and an integrated scenario. *Sediment. Geol.* 188-189, 35-67.

HIGH RESOLUTION BATHYMETRY AND SHALLOW SEISMIC STUDIES IN THE IZMIR GULF, AEGEAN SEA

Tarik Ilhan [1]*, Derman Dondurur [1], Dogan Yasar [1] and Erdeniz Ozel [1]
[1] Dokuz Eylul University Institute of Marine Sciences and Technology, 35340, Izmir, Turkey - tarik.ilhan@deu.edu.tr

Abstract
A new poster, based upon high resolution multibeam sonar surveys, shows the bathymetry of the Izmir Gulf basin. The image reveals in detail many features of the offshore. The shallow seismic investigations was done on the same profile of bathymetry and interpreted at advance geophysics processing and G.I.S programs.
Keywords: Bathymetry, Aegean Sea, Seismics, Swath Mapping, Gis

Material and Methods
The bathymetry of Izmir Gulf off western Turkey [1] is shown in this poster at 1:50,000 scale on the Universal Transverse Mercator (UTM) Projection (Zone 35), with WGS-84 datum. Water depths change from about 1m to over 60m in the Izmir Gulf. The survey was carried out between on June 2009 and April 2010 by the vessels R/V K.Piri Reis and Dokuz Eylul-1 using an ODOM ES3 multibeam echo sounder. The ES3 has 480 beams operating at 240 kHz spread over an arc of up to 150^0 total coverage, giving maximum swath coverage of up to 3 times of the water depth. Besides, seismic data collected by Triton SB-Logger and Strata Box Marine Geophysical Instrument. The study area approximately 380 km^2 and in this area the survey involved some 685,218 km of track.

Results
a) We produce high quality and standardized database of the seafloor in the Izmir Gulf, organized in the Marine G.I.S. b) This cartography will help at all sectors with interests in this area and allow to have an element of great help for the integral management of the coastal area and continental shelf and show the variety of the relief, the superficial geology [2], different types of sediments, and sedimentary bedforms generated, etc..

References
1 - Ten Veen, J.H., Boulton, S.J. and Alcicek, M.C., 2009. From palaeotectonics to neotectonics in the Neotethys realm: The importance of kinematic decoupling and inherited structural grain in SW Anatolia (Turkey). *Tectonophysics 473*, 261-281.
2 - Bozkurt, E. and Sozbilir, H., 2004. Tectonic evolution of the Gediz graben: field evidence for an episodic, two-stage extension in western Turkey. *Geol. Mag. 141* (1), 63-79.

GRAIN SIZE DISTRIBUTION ANALYSES AND FACIES CHARACTERISTICS OF THE HOMA LAGOON IZMIR BAY, AEGEAN SEA, WESTERN TURKEY

Ismail Isintek [1], Hasan Baha Buyukisisk [2] and Emine Erdem Yurur [3]*

[1] Celal Bayar University, Art and Science Faculty, Biology Department, 45030 Muradiye Campus MANISA/TURKEY - eyurur@gmail.com

[2] Dokuz Eylul University, Faculty of Engineering, Geology Depertment Tinaztepe Campus 35160 IZMIR/TURKEY

[3] Ege University, Fisheries Faculty, Hidrobiology Department, 35100 IZMIR/TURKEY

Abstract

This study aims to introduce mechanisms of sediment supply and processes and to investigate their effects on the formation of ecosystem and habitat, based on the grain size distribution of recent deposits of Homa Lagoon. According to the grain size distribution analyses, Homa Lagoon shows the typical characteristics of the following environments from the land to the sea. Samples of Homa lagoon pond show typical characteristics of lagoon pond deposits which are rich in coarse to medium-sized silt with negative skewness and imply that the lagoon was lack of effects of high-energy waves, storms and terrestrial sediment supply. It is concluded in this study that the Homa Lagoon has recently been supplied by low-energy fluids from the land and wave effect was very slow and low in sediment distribution.

Keywords: Sediments, Sediment Transport, Lagoons

Homa Lagoon covers an area of 1852 ha and is located in Izmir Bay, 40 km to the northwest of Izmir and 500 m to the south of Izmir Bird Paradise. More than 200 bird species live in the lagoon where fishery is one of the important occupations of local population. Birds and fishes use the lagoon for feeding, habitat, reproduction and maturation.

This study aims to introduce mechanisms of sediment supply and processes and to investigate their effects on the formation of ecosystem and habitat, based on the grain size distribution of recent deposits of Homa Lagoon**.**In order to accomplish this aim, Homa Lagoon is divided into three transverse and seven longitudinal sampling stations. Samples are 24 cm in thickness and were collected by Gravity Corer. According to the grain size distribution analyses, Homa Lagoon shows the typical characteristics of the following environments from the land to the sea:Marsh, landward lagoon beach, seaward lagoon beach, lagoon pond, sand barrier (dune) and shoal (back and front) (Reineck & Singh, 1980; Reineck, 1971).

That the coast and the sand barrier are rich in fine sand grains and include fine silt shows that wave effect is poor. Seaward lagoon beaches and poorly developed landward lagoon beaches are represented by medium to well sorted, fine sand with approximately symmetric skewness degree and reflect low wave effect. Samples of Homa lagoon pond show typical characteristics of lagoon pond deposits which are rich in coarse to medium-sized silt with negative skewness and imply that the lagoon was lack of effects of high-energy waves, storms and terrestrial sediment supply(Visher, 1969). It is concluded in this study that the Homa Lagoon has recently been supplied by low-energy fluids from the land and wave effect was very slow and low in sediment distribution. These conditions would be expected not to have sudden and disturbing impacts on habitat and ecosystem.

References

1 - Reineck, H., E., 1971. Der Küstensand. *Natur Mus.* 101, p. 45 -60.

2 - Reineck, H. E. & I. B. Singh., 1980. Depositional Sedimentary Environments. Springer Verlag, p. 549.

3 - Visher, G. S., 1969. Grain size distributions and depositional processes. *J. Sediment Petrol,* 39. P. 1077 – 1106.

THE LEVANTINE INTERMEDIATE WATER IN THE WESTERNMOST MEDITERRANEAN DURING THE LAST 20 KY CAL BP: GEOCHEMICAL PROFILES OF MANGANESE AND REDOX CONDITIONS.

Francisco Jose Jimenez-Espejo [1]*, Francisca Martinez-Ruiz [2], David Gallego-Torres [3] and Tatsuhiko Sakamoto [1]
[1] Institute of Biogeosciences, JAMSTEC, Yokosuka, Japan. - fjjspejo@ugr.es
[2] Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Granada, Spain.
[3] Faculty of Geosciences, University of Utrecht, Netherlands

Abstract

The Mediterranean thermohaline circulation plays a major role in the transference of energy between climate and ecosystems. The Levantine Intermediate Water (LIW) is a distinctive water mass that occupies intermediate layers in the entire Mediterranean Sea. Redox sensitive elements can be used in order to reconstruct the physic-chemical changes and the evolution of the LIW during the last glacial peridod. Different paleoceanographical proxies have been studied in three cores from the Alboran Sea and the Mn/Al ratio has been selected to reconstruct redox oscillations associated with redoxcline variations.

Keywords: Alboran Sea, Intermediate Waters, Paleoceanography, Redox

Introduction

The LIW is formed during winter in the Levantine basin and spreads to the entire Mediterranean until reaching the Alboran basin and the Gibraltar Strait. The LIW is essential to the Mediterranean thermohaline circulation and is the main contributor to the Mediterranean outflow (MOW), which has been associated to the recovery of the Atlantic thermohaline circulation and the subsequent end of the past glacial conditions [1].

Main text

Three cores have been analyzed that were recovered at different water depths in the Alboran slope: core TTR-300G (36º 21,532 N,1º 47,507 W 1860 mbsl), TTR-302G (36º 01,906 N, 1º 57,317 W at 1989 mbsl) and TTR-304G (36 º 19,873 N,1º 31,631 W at 2382 mbsl). The studied time interval spans the last 20 ky cal BP.

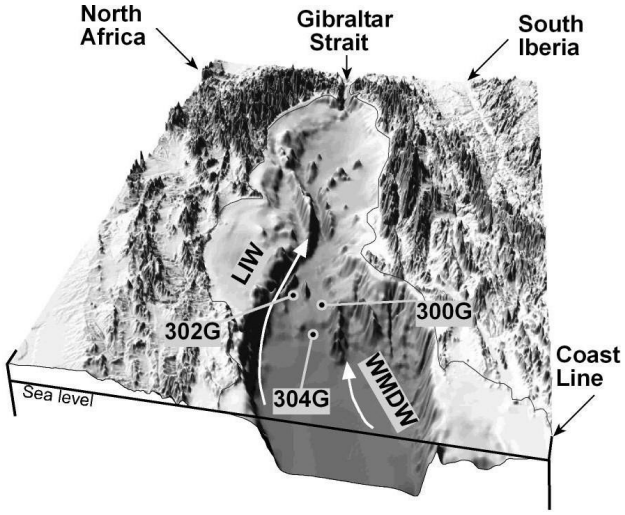


Fig. 1. Bathymetric map of the western Mediterranean showing the location of the studied cores, TTR-300G, TTR-302G and TTR-304G. Arrows represent the main oceanographic currents Levantine Intermediate Water (LIW) and Western Mediterranean Deep Water (WMDW)

The Mn/Al ratio profiles support that that this ratio is highly sensitive to paleoceanographical changes associated to different climate/oceanographic events as the Younger Dryas, the S1 sapropel deposition and the cold event 8.2 (Fig. 2). It is worth mentioning the obtained Mn/Al ratio obtained in the TTR-320G, that clearly records the changes occurred in the easten Mediterranean, as the end of the S1a and S1b sapropel deposition (Fig. 2). This location is therefore of key importance for the reconstruction of the physic-chemical conditions of the LIW when reaching the westernmost Mediterranean. When comparing the analyzed records, the Mn/Al enrichment peaks are not time coincident, especially during certain events such as the Last Glacial Maximum and the Heinrich event 1 (HE1) (Rectangles in Fig.2).

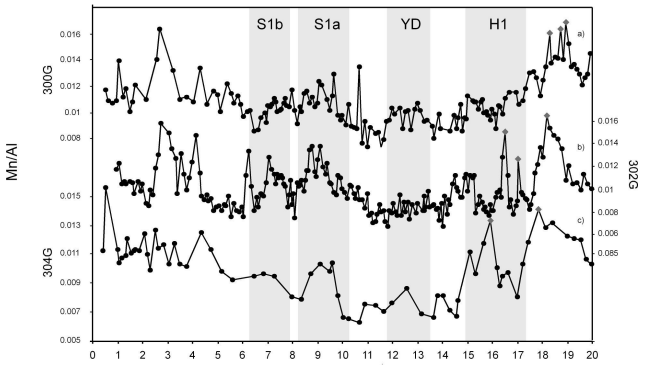


Fig. 2. Mn/Al ratio vs. age plots show profiles from the sallowest to the deepest sites: TTR-300G TTR-302G and TTR-304G. Grey vertical bars indicate Heinrich 1 event (H1), Younger Dryas (YD) and sapropel S1 (S1a and S1b) time intervals. Grey rectangles indicate discussed Mn/Al peaks.

Mn enrichment disparity is especially relevant because it is not observed in others geochemical profiles as as the Ba/Al ratio or the detrital record linked to the Mg/Al ratio [2]. In addition, the Mn/Al peaks are not coincident with the major climatic changes occurred in this region. Instead, the Mn content in these sediments mainly reflects redox conditions in bottom waters, and maximum Mn fluxes have been recognized when changes in bottom waters redox conditions occurred [3]. The most plausible explanation for the described Mn/Al enrichments is the presence of a redoxcline at the studied depths. The redoxcline could have beeen originated in relation to the boundary between the LIW and the WMDW water masses. Our data suggest a redoxcline deepening during the H1, as occurred with the base of the MOW in the Gulf of Cadiz at the same period. During the Last deglaciation and YD the Mn/Al enrichment peaks are no recorded, probably due to major changes in the water column in the WMS that allowed the formation of the Last Organic Rich Layer [3]. During the Middle and Late Holocene newly Mn/Al enrichement peaks are observed, after the ORL deposition, probably linked with WMDW variations associates to Bond cycles.

Acknowledgments: Projects CGL2009-07603,CTM2009-07715,CSD2006-00041(MICINN); 200800050084447 (MARM), Project RNM 05212, Research Group 0179 (Junta de Andalucía)and Training-Through-Research Programme.

References

1 - Voelker A.H.L., Lebreiro S.M., Schönfeld J., Cacho I., Erlenkeuser H., Abrantes F., 2006. Mediterranean outflow strengthening during northern hemisphere coolings: A salt source for the glacial Atlantic? *Earth Planet. Sci. Lett.* 245: 39–55

2 - Jimenez-Espejo F.J., Martinez-Ruiz M., Rogerson M., Gonzalez-Donoso J.M., Romero O.E., Linares D., Sakamoto T., Gallego-Torres D., Rueda Ruiz J.L., Ortega-Huertas M., Perez Claros J.A., 2008. Detrital input, productivity fluctuations, and water mass circulation in the westernmost Mediterranean Sea since the Last Glacial Maximum.*Geochem. Geophys. Geosyst*., 9, Q11U02.

3 - Rogerson M., Cacho I., Jimenez-Espejo F.J., Reguera M. I., Sierro F. J., Martinez-Ruiz F., Frigola J., Canals M., 2008. A dynamic explanation for the origin of the western Mediterranean organic-rich layers. *Geochem. Geophys. Geosyst., 9, Q07U01*.

MECHANISM OF THE LAND-SEA INTERACTIONS IN THE NERETVA RIVER DELTA (CROATIA): THE DISTRIBUTION PATTERN OF SEDIMENTS AND TRACE ELEMENTS

I. Jurina [1]*, M. Ivanic [1], N. Vdovic [1], N. Mikac [1] and I. Sondi [1]
[1] Rudjer Boskovic Institute, Zagreb, 10000, Croatia - ijurina@irb.hr

Abstract
This study, for the first time, examines the transport of sediments, their longitudinal distribution pattern, and their role in disposal of metals in river-dominated deltaic depositional system of the Neretva River and its adjacent coastal region. The results have shown that longitudinal distribution of metals in sediments follows the deposition pattern of the river-borne clayey mineral particles. The highest concentration of metals was found in the semi-enclosed area of the Neretva Channel. This region is characterized by deposition of fine-grained particles and prevalent accumulation of metals. This study exemplifies the role of Fe oxide and oxyhydroxide coatings on the clay mineral surfaces as a major factor in the adsorption and deposition pathways of trace elements.
Keywords: Adriatic Sea, Sediments, Trace Elements

Study Area
The Neretva River is the largest river on the Croatian part of the eastern Adriatic coast, and the only one forming a deltaic system. The length of the river is 240 km with the catchment area of about 10,100 km^2 [1]. Most of the sediment load carried by the river originates from the mountain region in the upper part of drainage area. At the river mouth, Neretva discharges its water into a semi-enclosed narrow bay called the Neretva Channel.

Materials and Methods
The field surveys in the Neretva delta and its adjacent coastal region were conducted in May and October 2009. Sediment cores up to 50 cm long were retrieved using Uwitec gravity corer at locations marked in Figure 1. The sediments were analysed in order to determine mineral composition, grain size distribution, SSA, CEC, and the concentration of trace elements.

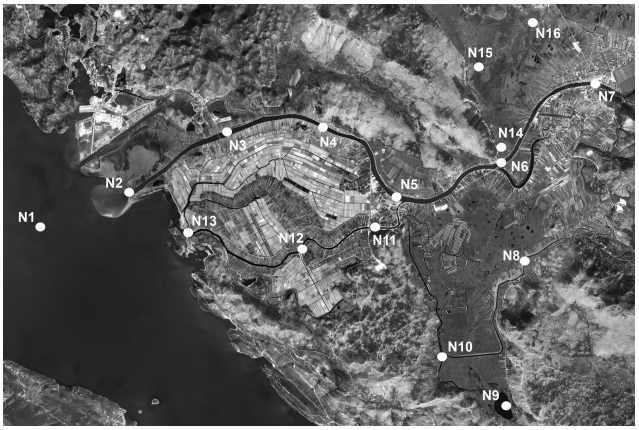


Fig. 1. The Neretva River delta system showing the sampling stations.

Results and Discussion
The Neretva River and its mouth provide a good example of the biogeochemical land-sea interactions occurring in a microtidal, low-wave energy, and river-dominated deltaic environment of the eastern Adriatic coast. As a result of a simple sedimentation dynamic, the distribution pattern of trace elements can be easily determined. According to Shepard's classification scheme [2] and the ratios of different grain size fractions, obtained by granulometric analyses, the surface sediments along the investigated area, were classified as sandy silts and silty sands with variable content of clay ranging from 1 to 12 %. All sediments were composed of quartz, calcite, dolomite, clay minerals, and feldspar and plagioclase. A significant difference in distribution of clay minerals was found. Their share is significantly higher in the adjacent coastal area, especially at the sampling station N1. The concentrations of metals showed a prevalent accumulation in the fine-grained, clayey fraction. Numerous studies have shown that clay minerals are important vehicles of transport of trace metals [3, 4]. They are involved in simultaneous and complex physico-chemical interactions with metal ions, organics, and iron and manganese oxides and oxyhydroxides. The latter, in the form of surface coatings, have significant impact on the adsorption, transport and deposition of metals. Figure 2 shows good correlation between content of Fe and the concentrations of Pb, Cu, Ni, and Co, in surface sediments. Accordingly, the distribution pathways of these metals are mainly governed by their direct binding on clayey particulate surfaces and/or on co-precipitated inorganic coatings.

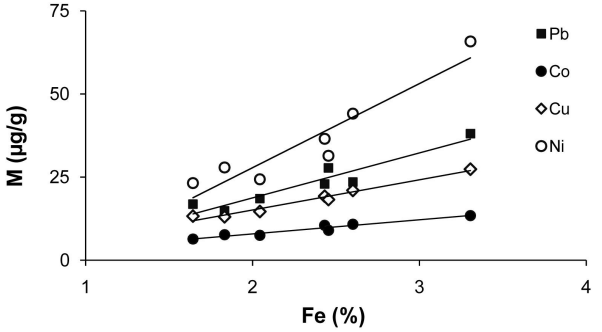


Fig. 2. Concentrations of trace metals (M) *vs*. Fe content in the surface sediments of the Neretva Channel (N1) and the Neretva River (N2-N7).

References
1 - Margeta, J., 2000. The Neretva River: integrated coastal area and river basin management. *In:* Ganoulis, J., Brilly, M., Murphy, I.L., (eds.) Transboundary water resources in the Balkans: initiating & sustainable regional cooperative network. Kluwer Academic Publ., Dordrecht, pp. 55-65.
2 - Shepard, F.P., 1954. Nomenclature based on sand-silt-clay ratios. *J. Sediment. Petrol.*, 24: 151-158.
3 - Sondi, I., Juracic, M., Prohic, E., and Pravdic, V., 1994. Particulates and the environmental capacity for trace metals. A small river as a model for a land-sea transfer system: the Raša River estuary. *Sci. Total. Environ.*, 155: 173-185.
4 - Sondi, I., Lojen, S., Juracic, M., and Prohic, E., 2008. Mechanisms of land–sea interactions – the distribution of metals and sedimentary organic matter in sediments of a river-dominated Mediterranean karstic estuary. *Estuar. Coast. Shelf Sci.*, 80: 12-20.

GEOMORPHOLOGICAL CHANGES OBSERVED BETWEEN 2006 AND 2009 IN A FRESHWATER SUBMARINE GROUNDWATER DISCHARGE (SGD), KALOGRIA BAY, SW PELOPONNISSOS, GREECE

Aristomenis P Karageorgis [1]*, Kostas Katsaros [1], Theodore D Kanellopoulos [1] and Evangelos Papathanassiou [1]
[1] Hellenic Centre for Marine Research, Institute of Oceanography, 19013, Anavyssos, Greece - ak@ath.hcmr.gr

Abstract
An impressive SGD in Kalogria Bay (SW Peloponnissos) was surveyed for the first time in 2006, revealing the existence of 2 major and 2 minor point sources of freshwater (salinity ~1-2); the discharge was ~1000 m^3 h^{-1}. The major point source was located inside a karstic cavity at 25 m depth. In July 2009, the site was revisited and divers reported that only the largest point source was active, whereas the roof of the cave had collapsed. The underwater discharge was not very strong, the water was flowing from many dispersed points, and salinity range was 20-36. Following visits will show if the SGD has turned to a diffused type and if changes in salinity are permanent, thus hampering the possibilities of water exploitation.
Keywords: Geomorphology, Hydrology, Coastal Processes, Salinity, Eastern Mediterranean

Introduction
Knowledge concerning submarine groundwater discharges (SGDs) has existed for many centuries [1]. However, SGDs were neglected scientifically for many years because of the difficulty in assessment and the perception that the process was unimportant [2]. Within the last two decades, that notion has changed, and now there is growing agreement that groundwater inputs can be chemically and ecological important to coastal waters [2]. Here we present new data regarding a large karstic freshwater SGD situated in Kalogria Bay, near Stoupa town, in SW Peloponnissos (Fig. 1). We focus on the geomorphological changes that were observed between 2006 and 2009, which may have consequences on the salinity of the discharged water.

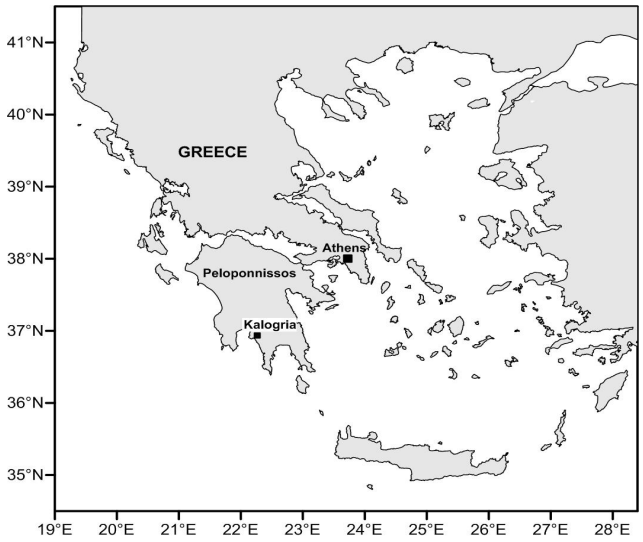


Fig. 1. Study area location map

Materials and Methods
The site was first visited in November and December 2006. During the latter visit, a multifaceted operation with divers, a remote operated vehicle, a portable CTD, and other equipment was implemented, which provided ample samples, videos, and other data from the site. Another visit was conducted in February 2008, and then in July, September, and October 2009. During 2009, apart from sampling with divers, a lander equipped with conductivity, temperature, current velocity, and g-ray spectrometer sensors was deployed permanently.

Results and Discussion
In 2006, the entire submarine spring feature formed an ellipsis with dimensions approximately 60 m x 40 m. Two major point sources discharged from Pleistocene conglomerates; the strongest, in terms of discharge, underwater spring emanated from the bottom (diameter ~2 m) of a cave, at 25 m depth. Salinity was ~1-2. Two minor SGDs discharged from the sandy seabed. Using ^{222}Rn measurements [3], the discharge was estimated at ~1000 m^3 h^{-1} at the second point source (water depth ~26 m). This morphology was maintained unaltered between 11-2006 and 2-2008. In July 2009, the underwater morphology appeared completely changed, as the roof of the cave, where the strongest SGD emanated, had collapsed almost entirely. The second SGD was completely filled with sand, and similarly, as the two smaller ones, they were inactive. The behavior of the major point source was also different, because the water was not any more concentrated as a single jet flowing from the bottom of the cave towards the surface, but it was scattered and emanated under rocks, from little cracks, and was generally rather diffused. Salinity measured in various spots was high (20-36). Elevated salinity can be attributed to the altered morphology of the submarine spring and particularly to the much more diffused character of the flow. However, it should not be disregarded that all measurements conducted in 2009 reflect summer and early autumn conditions, where rainfalls are practically absent in this territory, and therefore freshwater supply from the land should be at the lowest levels. In this perspective, the entire SGD represents minimum freshwater outflow allowing faster mixing with the sea water and brackish character of the outflowing water.
Measured flow velocity was on average 0.25 m s^{-1}, which corresponds to 900 m^3 h^{-1} if we assume that all small discharges cover a surface of just 1 m^2. This is a very conservative assumption, and the discharge can be many times higher. A possible explanation for the collapse of the conglomerates could be related to the extremely high rainfall that occurred during the winter and spring of 2009. Residents of Kalogria stated that during March 2009, after an intense rainfall, the SGD was 'boiling' at the sea surface, other smaller SGDs in the bay were also very active, and the sea was colored red. The red color is probably attributed to 'terra rossa', which is the final product of limestone dissolution during karst formation, and was transported to the sea.
In September and October 2009, a small freshwater spring (salinity ~3-4, temperature 12-13 °C) was spotted in Kalogria beach discharging exactly at the coast. According to geological observations conducted by the Agricultural University of Athens, this freshwater springs from the mountains and is hydrologically connected to the studied SGD. Most likely, freshwater reaches the SGD, but due to low discharge, it gets rapidly mixed with seawater between the impermeable marble bedrock and the sea bottom, where permeable formations prevail (sand, gravel, etc.). The available geological evidence suggests that a fault line or an impermeable rock formation (e.g. schist) blocks the freshwater flow on the marble bedrock and creates the SGD at this site.

Conclusions
Significant geomorphological changes have occurred in the studied SGD, which may have consequences on the type of the flow (from point to diffused), and possibly to the salinity of the water. Winter observations will reveal if elevated salinity is due to the sampling period (summer, low terrestrial water supply) or due to the changes of the rocky structure. Potential water exploitation will depend on a full year of observations.

References
1 - UNESCO, 2004. Submarine groundwater discharge. Management implications, measurements and effects. *IHP-VI, Series on Groundwater No. 5, IOC Manuals and Guides No. 44*, United Nations, Paris, 35p.
2 - Burnett W.C., Bokuniewicz H., Huettel M., Moore W.S. and Taniguchi M., 2003. Groundwater and pore water inputs to the coastal zone. *Biogeochem.*, 66: 3-33.
3 - Tsabaris C., Scholten J., Karageorgis A.P., Commanducci J-F., Georgopoulos D., Kwong L-L.W. and Papathanassiou E., 2009. Application of an in situ underwater gamma spectrometer as a marine radon progeny monitor: continuous monitoring of groundwater discharges into the coastal zone. *J. Environ. Radioactiv.*, submitted

ORGANIC DINOFLAGELLATE CYSTS AS BIO-INDICATOR OF MARINE POLLUTION, SOUTHEASTERN MEDITERRANEAN, EGYPT

Suzan Kholeif [1]*

[1] National Institute of Oceanography and Fisheries, Alexandria, El Anfoushy, Egypt - suzan_kholeif@yahoo.com

Abstract

This study depends on the detection of water pollution by means of the organic dinoflagellate cysts in bottom sediments collected from the coastal waters, southeastern Mediterranean close to Alexandria, Egypt. For the first time in the Egyptian Mediterranean waters, the dinoflagellate cysts are used as indicators of pollution to formulate environmental considerations on the effects of anthropogenic activity in the Abu Qir Bay. Fifty-two different dinoflagellate cyst morphotypes representing 15 genera were identified in the top 2 cm surface sediments. The most common cysts that were detected (*inter alia, Alexandrium minutum, A. affine, Alexandrium spp., Gymnodinium catenatum, Protoperidinium denticulatum*) are capable of producing paralytic shellfish poisoning (PSP), as a result of severe pollution.

Keywords: Eutrophication, Sewage Pollution

Introduction

Abu-Qir Bay(Figure 1) which islocated between Longitude 30° 50' and 30° 22' E and Latitude 31° 16' and 31° 28' N (about 35 km east of Alexandria), was considered before 1965, as one of the most important breeding and nursery ground for economically important fish and shellfish. The Bay receives considerable amounts of waste waters sources including drainage water from El-Behera province as well as industrial waste from several industries (Tayel, 1992). Such pollutants have a drastic effect on various aquatic fauna and flora.

Question To what extent has the current polluted marine environment effect on dinoflagellate cysts types and distribution in the bottom sediments? The answer to this question is the aim of the present study.

Materials and Methods

Eighteen bottom sediment samples from 18 stations covering nearly different sites of the Bay (Figure 1), were collected, during the end of May and December 2006, using Van Veen grab sampler, in addition to short core sample (~25 cm length). The selected bottom sediments and core samples were treated for palynological study by standard palynological technique for marine sediment. The quantitative and qualitative results for dinocysts identification were based on the published references such as: Fensome et al. (1993), Williams et al (1998), Rochon et al. (1999) and Matsuoka and Fukuyo (2000).

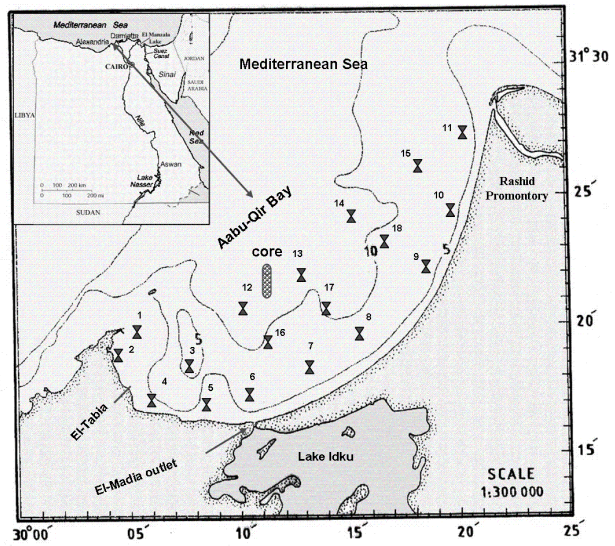


Fig. 1. Location map of Abu Qir bay, showing locations of core and bottom sediment samples

Result and Discussion

Dinocysts abundance varied greatly among studied locations. The high number of cysts was observed in the near shore stations can be explained as the extensive human activities in this area which led to the accumulation of muddy sediments. The number of cysts, particularly heterotrophic ones, (7646 cyst/g) is significantly high (Figure 2), most of them are toxic species.

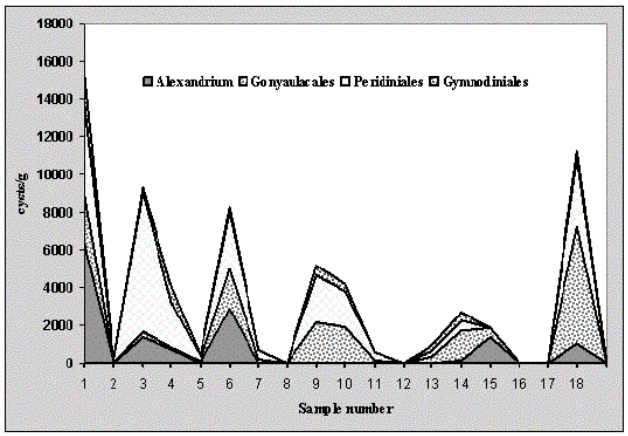


Fig. 2. Diagram showing the concentration of*Alexandrium* and other Cyst orders in the bottom sediments collected during May 2006

Conclusion

1. *Alexandrium* cystshave been seen in surface sediment layers in the vicinity of the most coastal stations. This species was the most abundant of the cyst types in the area. However, *Alexandrium* cysts showed lower surface concentrations or are missing in several stations of the center of the bay.
2. Cysts of three potentially toxic dinoflagellate species, *Alexandrium minutum, A. affine* and *Gymnodinium catenatum* were detected at E-Mena, El Madia, in bottom sediments and in the core sediments at 5-15 cm depth.
3. The high concentration and occurrence of dinoflagellate cysts in the Abu Qir Bay are suspected to reflect the serious changes in the environment and anthropogenic activities in that coastal zone.

References

1 - Fensome, R.A., Taylor, F.J.R., Norris, G., Sarjeant, W.A.S., Wharton, D.I., Williams, G.1993. A classification of living and fossil dinoflagellates. *Micropaleontology Special Publication*, 7: 351 pp.

2 - Matsuoka, K. & Y. Fukuyo, 2000: Technical Guide for Modern Dinoflagellate Cyst Study. WESTPACHAB/WESTPAC/IOC, Japan Society of the Promotion Science, Tokyo.

3 - Rochon, A., de Vernal, A., Turon, J-L., Matthiessen, J., and Head, M.J., 1999. Distribution of recent dinoflagellate cysts in surface sediments from the North Atlantic ocean and adjacent seas in relation to sea-surface parameters. : *American Association of Stratigraphic Palynologists Foundation Contribution*, No. 35.

4 - Tayel, F.T., 1992. The physical and chemical conditions of Abu Qir Bay waters. Bull. High Instit, *Pub. Health. XXII* (1): 87-99.

5 - Williams, G.L., Lentin, J.K., and Fensome, R.A., 1998. The Lentin and Williams index of fossil dinoflagellates; 1998 edition. *American Association of Stratigraphic Palynologists Contributions Series 34*, 817 p.

CORE-TOP CALIBRATION USING THE LIPID-BASED TEMPERATURE PROXIES $U^{K'}_{37}$ AND TEX_{86} ON THE SOUTHERN ITALIAN SHELF (SW ADRIATIC SEA, GULF OF TARANTO)

Arne Leider [1]*, Kai - Uwe Hinrichs [1], Gesine Mollenhauer [2] and Gerard J.M. Versteegh [1]
[1] Dept. of Geosciences, University of Bremen, D-28359 Bremen, Germany - ar_le@uni-bremen.de
[2] Alfred Wegener Institute for Polar and Marine Research, D-27570 Bremerhaven, Germany

Abstract
The core-top calibration of lipid-based temperature proxies along the south Italian shelf suggests that $U^{K'}_{37}$ primarily records winter temperatures while TEX_{86} tend to reflect summer temperatures, in particular in offshore regions. Additionally, a bias of TEX_{86} due to terrestrial input or transport cannot be excluded. Our study provides a robust basis for future reconstructions of winter climate variability in this region during the last two millennia in sediment cores with a temporal resolution of 4 yrs, which is likely to provide important information on the extension of the AO/NAO in the Mediterranean.
Keywords: Adriatic Sea, Temperature

Introduction The southward extension of the AO/NAO during winter is crucial for the Mediterranean water budget. The ESF project MOCCHA aims at providing climatic reconstructions for the Gulf of Taranto (S. Italy) with a <4-year resolution. The sediments in this region are excellently suited for this purpose [e.g., 1]. To fully exploit the sedimentary archive, a better understanding of the relation between environmental conditions and sedimentary composition is needed. Therefore a core-top calibration of molecular paleotemperature proxies has been performed. The lipid-based $U^{K'}_{37}$ and TEX_{86} proxies presumably reflect the temperature in the habitat of the source organisms, i.e., haptophytes and crenarchaeota, respectively [Fig. 1].

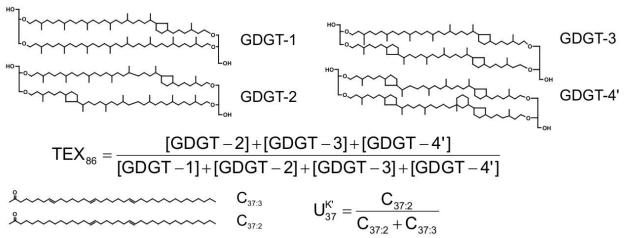


Fig. 1. Structures of GDGTs and alkenones and their related temperature proxy indices, TEX_{86} and $U^{K'}_{37}$, respectively [2, 3].

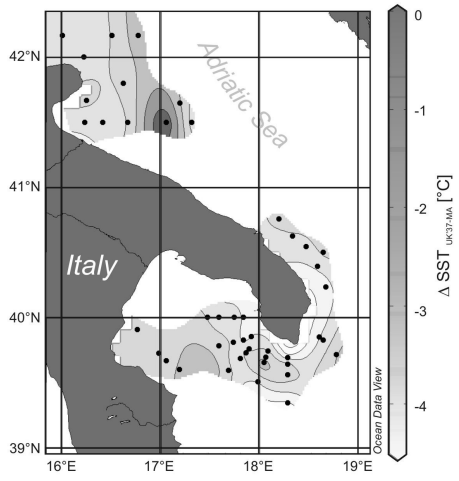


Fig. 2. Map of southern Italy showing the difference between alkenone-derived SST and satellite-based mean annual SST ($\Delta SST_{UK'37-MA}$) at the SW Adriatic coast and the Gulf of Taranto.

Usually, the transfer functions applied to the lipid composition of the surface sediments closely agree with the annual mean temperature in the overlying surface waters [2-5]. In many open oceanic settings the main productivity takes place when ambient water temperatures are close to the annual mean [4], which is not necessarily the case in the Mediterranean [e.g., 6]. Here, we elucidate the temporal relation between the lipid composition of sediment surface samples and monthly satellite-derived sea surface temperature and productivity data at the south Italian shelf.

Material and Methods The analysed sediments represent the top 2 cm of multicores from 48 stations obtained during P339 POSEIDON cruise 'CAPPUCCINO' in June 2006. Homogenized samples were extracted by using an accelerated solvent extractor (ASE 200, DIONEX). Alkenones were quantified using GC-FID. Analysis of GDGTs was based on HPLC-APCI/MS [7]. The most recent global transfer functions were used for temperature conversion [4, 5]. Satellite based environmental data and mean annual sea surface temperatures (SST_{MA}) derive from OBPG MODIS-Aqua Monthly Global 9-km data base [8].

Results and discussion In our study, the alkenone-based $U^{K'}_{37}$ reflects winter/spring SST [Fig. 2]. This agrees with maximum haptophyte production in the colder season as evidenced by chlorophyll data and sediment trap analysis. In contrast, the TEX_{86} data are more complicated. For the near-shore sites the TEX_{86} suggests that the GDGTs have been produced in winter but with increasing distance from shore the inferred ambient water temperature increases; consequently most offshore sites reflect summer SST. This is probably due to differences with respect to timing and/or depth of production, or transport of allochthonous GDGTs. Our core-top calibration documents varying degrees of seasonal bias of the two SST proxies in a regional context. This improved understanding of SST signal formation at the Gallipoli shelf provides a robust basis for future examination of temperature changes in sedimentary records covering the last millennia.

References
1 - Versteegh, G.J.M., de Leeuw, J.W., Taricco, C. and Romero, A., 2007. Temperature and productivity influences on $U^{K'}_{37}$ and their possible relation to solar forcing of the Mediterranean winter. *Geochem., Geophys., Geosys.*, 8: Q09005, doi:10.1029/2006GC001543.

2 - Prahl, F.G., Wakeham, S.G., 1987. Calibration of unsaturation patterns in long-chain ketone compositions for palaeotemperature assessment. *Nature*, 330: 367-369.

3 - Schouten, S., Hopmans, E.C., Schefuss, E., Sinninghe Damsté, J.S., 2002. Distributional variations in marine crenarchaeotal membrane lipids: a new tool for reconstructing ancient sea water temperatures? *Earth Planet. Sci. Lett.*, 204: 265-274.

4 - Conte, M.H., Sicre, M.-A., Rühlemann, C., Weber, J.C., Schulte, S., Schulz-Bull, D., Blanz, T., 2006. Global temperature calibration of the alkenone unsaturation index ($U^{K'}_{37}$) in surface waters and comparison with surface sediments. *Geochem. Geophys. Geosyst.*, 7: Q02005, doi:10.1029/2005GC001054.

5 - Kim, J.-H., Schouten, S., Hopmans, E.C., Donner, B., Sinninghe Damsté, J.S., 2008. Global sediment core-top calibration of the TEX_{86} paleothermometer in the ocean. *Geochim. Cosmochim. Acta*, 72: 1154-1173.

6 - Ziveri, P., Rutten, A., de Lange, G.J., Thomson, J., Corselli, C., 2000. Present-day coccolith fluxes recorded in central eastern Mediterranean sediment traps and surface sediments. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, 158: 175-195.

7 - Schouten, S., Huguet, C., Hopmans, E.C., Kienhuis, M.V.M., Sinninghe Damste, J.S., 2007. Analytical Methodology for TEX_{86} Paleothermometry by High-Performance Liquid Chromatography/Atmospheric Pressure Chemical Ionization-Mass Spectrometry. *Anal. Chem.*, 79: 2940-2944.

8 - Zonneveld, K.A.F., Chen, L., Möbius, J., Mahmoud, M.S., 2008a. Environmental significance of dinoflagellate cysts from the proximal part of the Po-river discharge plume (off southern Italy, Eastern Mediterranean). *J. Sea Res.*, In Press.

ARGUMENTS IN FAVOUR OF A HOLOCENE RAPID TRANSGRESSION IN THE BLACK SEA

Gilles Lericolais [1]*, Nicolas Loget [1] and Guillaume Soulet [1]
[1] IFREMER BREST, Département Géosciences Marines, 29280, Plouzané, France - gilles.lericolais@ifremer.fr

Abstract
Since Ryan et al. [1] theory about a rapid reconnection between the Black Sea and the Marmara Sea in the Holocene, an important international work have been undertaken to study the Quaternary water level fluctuations of these two bodies. It is now well established that the Black Sea has encountered complex water level fluctuations with high lake levels occurring during wet and melting period after the LGM and low lake levels occurring during drier conditions as the Younger Dryas was for this region. This presentation will summarise results obtained in the Black Sea from different research cruises and compare them with other semi-enclosed basins. These permit a rise in the understanding of the mechanisms linked to high resolution sequence stratigraphy preservation and how they have recorded the abrupt climate changes of the last deglaciation
Keywords: Black Sea, Bosphorus, Seismics

The location of the Black Sea, between Europe and Asia, makes its water level dependent on Eurasian climatic fluctuations. This inland sea is a perfect present-day example of what is a marginal basin where connection changes dramatically with sea level. The Black Sea is at present the world's largest anoxic basin, making it an important modern analogue for past anoxic conditions, while during the last glacial period, it was a low salinity oxygenated lake, isolated from the Mediterranean. The Black Sea and the low sea level periods when were deposited lake sediments represents valuable archives for the study of past climate changes. Actually, the glacial period northern ice cap prevented major East European rivers to flow north as they do today. During ensuing interglacial periods, these rivers were diverted to the south in the direction of the Black Sea and Caspian Sea receiving basins and consequently have increased the size of these Drainage Basins Therefore, unique conditions specific to the Black Sea were established while this water body became isolated from the Global Ocean. This results in avoiding the hysteresis effect which is the latent period needed by the Global Ocean to respond to the consequences of ice melting. This presentation is part of one of the objectives of the INQUA/IGCP 521 project (Black Sea-Mediterranean Corridor during the last 30 ky: sea level change and human adaptation) which is to obtain a good as possible reconstruction of climate dynamics and the changes from wet to arid periods together with the determination of palaeodepths. Such results are of interests for the CIESM as they will lead to a cooperation in the construction of a sea-level curve for the Black Sea. Presently, it is well established that the Black Sea has encountered complex water level fluctuations with high lake levels occurring during wet and melting period after the LGM and low lake levels occurring during drier conditions as the Younger Dryas was for this region. As the Black Sea, abrupt Sea-level rises have been recorded in many different semi-enclosed basins around the world. The link to rapid transgressions is easy to do, even if the mechanisms are completely different. Large and rapid releases of freshwater from ice sheets since the LGM to sensitive areas may also arise from several mechanisms. The last deglaciation provides the level of preservation necessary to identify specific mechanisms of ice-sheet forcing and attendant climatic responses. The presentation will summarise results obtained in the Black Sea from different research cruises and compare them with other semi-enclosed basins. These permit a rise in the understanding of the mechanisms linked to high resolution sequence stratigraphy preservation and how they have recorded the abrupt climate changes of the last deglaciation. When the Black Sea was isolated, both the lack of saltwater input and the increase of fresh water run-off from the rivers, led to reduced salinity levels in the Black Sea. This process happening during the glacial periods, linked to water level fluctuation, is measured in the fauna succession showing an abrupt change from salt-water to fresh/brackish-water species. The initial hypothesis of a rapid saltwater flooding of the freshwater lake that was the Black Sea in the Late Glacial Maximum (LGM) was proposed since 1996 by Ryan et al. The flood hypothesis raised controversy and initiated refutation, but recently also received supports The European Project ASSEMBLAGE (EVK3-CT-2002-00090) provided geophysical and sedimentary data collected in the north-western part of the Black Sea from the continental shelf and slope down to the deep-sea zone. This project focused on applying sequence stratigraphic models to seismic data recorded on the north-western Black Sea shelf, in order to correlate the sequences interpreted using seismic stratigraphy methods to sea-level fluctuations. To achieve the project's objectives, very high resolution seismic data were acquired during the BlaSON cruises (1998 and 2002) on board the research vessel LE SURO; and during the ASSEMBLAGE 1 (2004) cruise on board the research vessel LE MARION DUFRESNE. During the first two cruises paleo-shorelines and sand ridges were identified and a set of seismic data was acquired on these targets to support pseudo 3D analyses. This coupled with a multiproxy approach emphasizes that the Black Sea water level is dependent on Eurasian climatic fluctuations. This sequence stratigraphy study is validated by dated samples obtained from long cores (up to 50 m long) providing a firm calibration of Black Sea water level fluctuation since the LGM. It especially shows that the Black Sea experienced a contemporary rise in water level with the melting of the Fennoscandian Ice sheet followed by a drop of the water level from the Younger Dryas to the Pre-Boreal. This recent lowstand is confirmed by the presence of the forced regression sequences, the wave cut terrace and the coastal dunes still preserved on the shelf, even after the Black Sea was rapidly invaded by Mediterranean/Marmara marine waters.

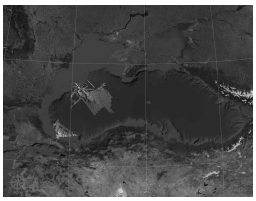


Fig. 1. BlaSON and ASSEMBLAGE survey multibeam results for the Black Sea

References
1 - Ryan, W. B. F. et al. An abrupt drowning of the Black Sea shelf. 1997. *Marine Geology 138*, 119-126.
2 - Ross, D. A. & Degens, 1974. E. T. in The Black Sea - Geology, Chemistry and Biology (eds. Degens, E. T. & Ross, D. A.) 183-199 (Amer. Assoc. Petrol. Geol., Tulsa).
3 - Ryan, W. B. F., Major, C. O., Lericolais, G. & Goldstein, S. L. .2003. Catastrophic Flooding of the Black Sea. *Annu. Rev. Earth Planet. Sci*. 31, 525-554.
4 - Deuser, W. G.1974. In The Black Sea - Geology, Chemistry and Biology (eds. Degens, E. T. & Ross, D. A.) 133-136 (Am. Assoc. Petrol. Geol, Tulsa (US).
5 - Arkhipov, S. A., Ehlers, J., Johnson, R. G. & Wright, H. E. J. 1995. Glacial drainage towards the Mediterranean during the middle and late Pleistocene. Boreas 24, 196-206.
6 - Aksu, A. E. et al. Persistent Holocene outflow from the Black Sea to the eastern Mediterranean contradicts Noah's Flood hypothesis. GSA Today 12, 4-10 (2002)
7 - Gorur, N. et al. 2001. Is the abrupt drowning of the Black Sea shelf at 7150 yr BP; a myth? *Marine Geology* 176, 65-73.
8 - Hiscott, R. N. et al. 2002. Deltas south of the Bosphorus Strait record persistent Black Sea outflow to the Marmara Sea since ~10 ka. *Marine Geology 190*, 95-118
9 - Yanko-Hombach, V., Gilbert, A. S., Panin, N. & Dolukhanov, P. M. 2006. The Black Sea Flood Question (ed. NATO) (Springer, New-York (USA).
10 - Lericolais, G., Popescu, I., Guichard, F. & Popescu, S. M. 2007. In Coastline Changes: Interrelation of Climate and Geological Processes (eds. Harff, J., Hay, W. W. & Tetzlaff, D. M.) 171-188 (GSA Books; Allen Press, Inc., Special Paper 426).

VERY LARGE SUBAQUEOUS DUNES ALONG AN OUTER CONTINENTAL SHELF (SOUTHERN EBRO CONTINENTAL SHELF; WESTERN MEDITERRANEAN SEA)

C. Lo Iacono [1], J. Guillen [2]*, P. Puig [2], A. Palanques [2], M. Ribó [2], M. Farrán [2], M. Ballesteros [3] and J. Acosta [3]
[1] Unidad de Tecnología Marina, CSIC, P.o Maritimo de la Barceloneta 37-49, 08003 Barcelona, Spain
[2] Instituto de Ciencias del Mar, CSIC, P.o Maritimo de la Barceloneta 37-49, 08003 Barcelona, Spain - jorge@utm.csic.es
[3] Instituto Español de Oceanografia, IEO, Corazon de María 8, 28002 Madrid, Spain

Abstract
High resolution Multi Beam data and sediment samples were collected across the outer shelf region of the Columbretes Islands (Southern Ebro continental shelf, Western Mediterranean Sea). Very large subaqueous dunes were observed across relict sand bodies and their distribution and morphological characteristics have been analyzed to evaluate possible potential formation mechanisms. It is discussed that these bedforms could be produced by the action of the Liguro-Provencal-Catalan (LPC) geostrophic current, flowing southward and reaching very intense near-bottom curents when interacting with the local geomorphology of the study area.
Keywords: Continental Shelf, Geomorphology, Swath Mapping, Western Mediterranean

Large and very large subaqueous dunes [1] have been observed in a number of outer shelf regions around the world, usually developing on fossil sand bodies and ridges [2,3]. Dunes observed on outer shelves usually display large dimensions with maximum longitudes reaching up to 500 m and heights up to 20 m [3,4]. Forcing mechanisms able to induce their formation have been described as strong bottom currents related to tidal variations and water masses flowing under geostrophic conditions, usually controlled and enhanced by local geomorphologic configurations [2,3,5]. In this study, such bed features have been recognized around the Columbretes Islands, mapped and measured, with the aim to reconstruct which are the forcing processes that could generate them in relation to the local settings of the area.

Swath-bathymetry around the Columbretes Islands was collected using the Simrad EM-300 30 kHz (R/V Vizconde de Eza) and the Elac Seabeam 1050D 180 kHz (R/V Garcia del Cid) Multi Beam echo-sounders for a 50-400 m water depth range. Additionally, sediment samples were recovered by means of a Van-Veen grab and a HAPS corer, to carry out grain size analysis of surface sediments. Bathymetric data revealed the presence of three main relict sand bodies along the outer shelf, for a 80-116 m depth range, above which asymmetrical, slightly asymmetrical and symmetrical large and very large 2D and 3D subaqueous dunes were observed (Fig.1). Dunes range from 150 to 760 m in wavelength and from tens of cm to 6 m in height.

These bedforms are composed of sandy sediments, presumably coming from the degraded relict sand bodies on which they developed, mixed to fine fractions, coming from the recent draping holocenic sediments. The orientation of the dunes is SSW and progressively turns to W directions moving towards the southernmost sector of the area, following the trend of the shelf-edge. Observed dunes display a strong asymmetric profile for those occurring along the shelf-edge (Symmetry Index (SI): 2.6) and lose progressively their asymmetry towards the inner portion of the shelf (SI: 0.5), being 0.6 the minimum SI value to classify the dunes as asymmetric [6]. The subaqueous dunes observed along the studied region are amongst the largest ever recognized on an outer shelf setting. Morphologic characters and the orientation towards SW and W directions suggest the LPC current as the primary forcing factor in their formation.

Contemporary hydrodynamic measurement at the Ebro continental shelf-edge show that near-bottom wave action is negligible in this area, whereas maximum shear stresses induced by currents are able to resuspend fine sand particles and prevent the relict transgressive deposits from being covered by mud [7]. However, recorded values are below the critical shear stresses for transport the relict coarse sands found in the study area and form large bedforms. The comparison of successive bathymetric images and the aspect of the wavelenght-height regression curve suggest that the described very large dunes are inactive features over long periods, as observed in similar environments along several continental margins. Thus, the morphological configuration of the Columbretes outer shelf must have played a crucial role in enhancing the southward flowing bottom currents during energetic hydrodynamic events, giving them the potential to generate bedforms.

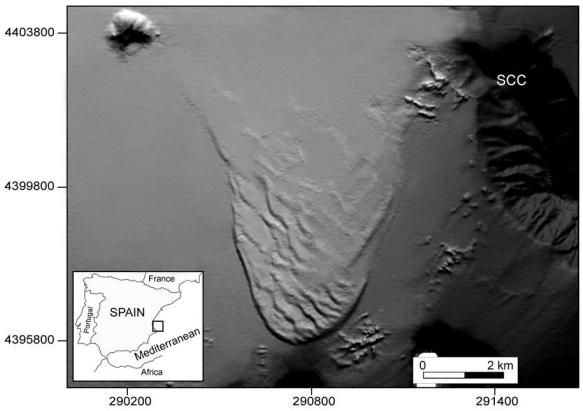


Fig. 1. Shaded relief image of large subaqueous dunes developed on relict sand bodies along the Columbretes outer shelf. SCC: Southern Columbretes Canyon.

References
1 - Ashley, G.M., (1990). Classification of large-scale subaqueous bedforms: a new look at an old problem. SEPM Bedforms and Bedding Structures Research Symposium. *J Sediment Petr* 60, 160–172.
2 - Bassetti, M.A., G. Jouet, F. Dufois, S. Berné, M. Rabineau, M. Taviani (2009). Sand bodies at the shelf edge in the Gulf of Lions (Western Mediterranean): Deglacial history and modern processes. *Mar Geol 234*, 93-109.
3 - Gardner, J.V., B.R. Calder, J.E. Hughes Clarke, L.A. Mayer, G. Elston, Y. Rzhanov (2007). Drowned shelf-edge deltas, barrier islands and related features along the outer continental shelf north of the head of De Soto Canyon, NE Gulf of Mexico. *Geomorphology 89*, 370-390.
4 - Van Landeghem K.JJ., A.J. Wheeler, N. Mitchell, G. Sutton (2009). Variations in sediment wave dimensions across the tidally dominated Irish Sea, NW Europe. *Mar Geol 263*, 108-119.
5 - Barrie, J.V., K. Conway, K. Picard , H.G. Greene (2009). Large-scale sedimentary bedforms and sediment dynamics on a glaciated tectonic continental shelf: Examples from the Pacific margin of Canada. *Cont Shelf Res* 29, 796-806.
6 - Allen J.R.L. (1982). Sedimentary Structures: their character and physical basis. Elsevier, Amsterdam, 593 pp.
7 - Palanques, A., P. Puig, J. Guillén, J. Jimenez, V. Gracia, A. Sanchez-Arcilla, O. Madsen (2002). Near-bottom suspended sediment fluxes on the microtidal low-energy Ebro continental shelf (NW Mediterranean). *Cont Shelf Res 22*, 285-303.

A GEOSTATISTICAL ANALYSIS OF PRODELTAIC UNDULATIONS OFF THE GUADALFEO RIVER IN THE NORTHERN MARGIN OF THE ALBORAN SEA, WESTERN MEDITERRANEAN BASIN

F. J. Lobo [1], J. A. Goff [2], L. M. Fernández-Salas [3]*, P. Bárcenas [4] and V. Díaz-Del-Río [3]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga. - luismi.fernandez@ma.ieo.es
[2] CSIC-IACT, Facultad de Ciencias, Avenida de Fuentenueva s/n, 18002 Granada, Spain
[3] UTIG, University of Texas at Austin, Austin, TX 78758, USA
[4] Dep. Análisis Matemático, Universidad de Málaga, Campus de Teatinos s/n, 29080 Málaga, Spain

Abstract

A geostatistical analysis of multibeam bathymetric data in two fields of prodeltaic undulations located off the Guadalfeo River, northern margin of the Alboran Sea, was conducted in order to obtain useful insights into genetic mechanisms. The geostatistical analysis was based on the determination of characteristic parameters and derived relationships. Our results support the contention that prodeltaic undulations off the Guadalfeo River should be regarded as sediment waves, mainly generated by strong normal-to-contour sediment flows with a riverine origin.

Keywords: Deltas, Continental Shelf, Geomorphology, Swath Mapping, Alboran Sea

A detailed study of the along- and across-shelf variability of geostatistical parameters such as rms (H), strike azimuth with respect to north (Θ_s), characteristic width (L_n) and characteristic length (L_s) defining the von Kárman covariance function, as well as the wave or vertical form index (L_n/H) and aspect ratio (L_s/L_n), provides valuable information about the genetic interpretation of submarine undulations found in highly dynamic prodeltaic systems. Those systems have been particularly documented in several settings of the Mediterranean Sea [1, 2, 3], a region characterized by seasonal climatic patterns and strong physiographic control on drainage basins. Our analysis provides evidence to support the hypothesis that the prodeltaic undulations can be considered as a type of sediment waves, resulting as the final products of energetic sediment flows emanating from river outlets.

Overall, geomorphological statistics indicate that the undulations under consideration bear high similarity with prodeltaic undulations developed in deltaic systems where a primary control of hyperpycnal flows has been proposed. The parameter values in the Guadalfeo River prodelta (Fig. 1) suggest the imprint of very intense sediment flows, with increased proportions of bedload sediment transport in relation with other undulation areas. This may be a consequence of the extreme seasonality and torrentiality dominant in the drainage basin of the feeding system.

Most of the geostatistical parameters are disposed in basically consistent distribution patterns, especially in the along-shelf direction. Amongst them, the L_n/H ratio observes the most clearly discerned geomorphological patterns, by defining two identifiable depositional axes, whose location seems to be controlled at large by changing river mouth position. The most recent, western undulation field is highly symmetrical,with higher H and lower L_n/H and L_s values, suggesting the action of very intense and focused flows, with relatively high amounts of bedload sediment with decrease rapidly both laterally and downslope. In contrast, the eastern field shows lower H and higher L_n/H and L_s values, indicating the influence of less energetic flows with increased proportion of suspended sediment. In the end, those differences are also indicating a temporal change, as the western field undulations appear to be active, relatively in equilibrium with recent/present flow regime, whereas the more subdued profile of the eastern field undulations would indicate a higher quiescence.

Changes of Θ and L_s also support a main genetic mechanism through normal-to-contour flows, as the undulations are disposed around two adjacent lobes and show relatively low lateral continuity when compared to other Mediterranean undulations. Those parameters fit with the depositional model, described by two main point sources that irradiate sediments concentrically. In contrast to the previous parameters, L_n does not show a predictable pattern, as no significant systematic change is detected in the study area.

Acknowledgements

Multibeam data were collected within the framework of the ESPACE project. Additionally, this work represents a contribution to the research projects MOSAICO and CTM2005-04960/MAR. This contribution was elaborated during a research stage of the first author funded by the "José Castillejo" program (JC2008-00210) at the Institute for Geophysics, Jackson School of Geosciences, University of Texas at Austin, during May to August 2009.

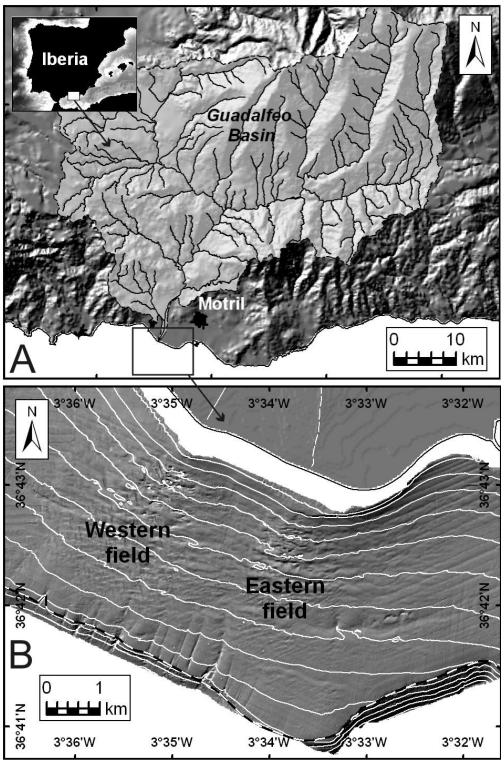


Fig. 1. Prodeltaic undulations off the Guadalfeo River: A) Geographical setting of the study area, located in the northern margin of the Alboran Sea,western Mediterranean Basin. B) Shaded relief of the study area, showing two main undulation fields (western and eastern).

References

1 - Cattaneo A, Correggiari A, Marsset T, Thomas Y, Marsset B, Trincardi F, 2004. Seafloor undulation pattern on the Adriatic shelf and comparison to deep-water sediment waves. *Mar Geol* 213(1-4):121-148.

2 - Fernández-Salas LM, Lobo FJ, Sanz JL, Díaz-del-Río V, García MC, Moreno I, 2007. Morphometric analysis and genetic implications of pro-deltaic sea-floor undulations in the northern Alboran Sea margin, western Mediterranean Basin. *Mar Geol* 243(1-4):31-56.

3 - Urgeles R, De Mol B, Liquete C, Canals M, De Batist M, Hughes-Clarke JE, Amblàs D, Arnau PA, Calafat A, Casamor JL, Centella V, De Rycker K, Fabrés J, Frigola J, Lafuerza S, Lastras G, Sànchez A, Zuñiga D, Versteeg W, Willmott V, 2007. Sediment undulations on the Llobregat prodelta: Signs of early slope instability or sedimentary bedforms? *Journal of Geophysical Research-B Solid Earth* 112(B05102).

RESUSPENSION EVENTS AND SEDIMENT FLUXES ACROSS BARCELONA CONTINENTAL SHELF

Laura López [1]*, Jorge Guillén [1], Albert Palanques [1] and Pere Puig [1]
[1] Institut de Ciencies del Mar (CSIS),08003 Barcelona, Spain - llopez@icm.csic.es

Abstract
Near-bottom sediment fluxes were measured at several locations across the Barcelona continental shelf (NW Mediterranean) during the SEDMET Study. Current meters equipped with turbidimeters were installed on instrumented tripods deployed at 20, 30 and 40 m water depth. Measurements of near bottom currents and water turbidity, from October 2007 to June 2008, in combination with wave data provided information about the physical forcing and resulting resuspension and sediment fluxes on this Mediterranean continental shelf. This contribution analyses the results obtained during the first recording period (September – December, 2007) characterized by a high wave-energy regime. During this period, six moderate storms occurred, being identified as the main contributors to the sediment resuspension events recorded between 20 and 40 m depth.
Keywords: Sediment Transport, Continental Shelf, Western Mediterranean

Sediment resuspension in the Western Mediterranean Sea is caused primarily by the wave-storm activity when wave periods increase significantly. Some authors showed that sediment resuspension in response to storm waves on the Ebro Margin (NW Mediterranean) is mainly effective on the inner-shelf region [1] [2]. The present project involves studying resuspension and sediment transport events in a littoral system affected by industrial and urban activities, Barcelona (NW Mediterranean) (Figure 1).

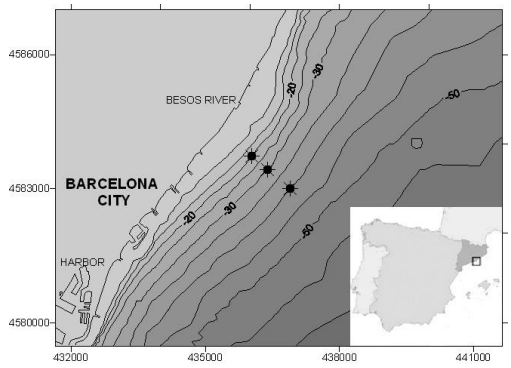


Fig. 1. Map of the Barcelona continental shelf showing the three tripods locations. Depth contours and UTM units are in meters.

During the SEDMET Project, three benthic tripods were deployed in the northern Barcelona continental shelf at 20, 30 and 40 m water depth (Figure 1). Each tripod was equipped with an Aanderaa Doppler current meter (RCM9) coupled with a pressure sensor, a temperature sensor, and 2 Aanderaa turbidimeters of different ranges. These sensors were measuring at 0.6 meters above bottom (mab). In addition, an NKE ALTUS 2 Hz altimeter and a sediment trap were incorporated to the tripods structures. For this study, the current meter recording intervals were set at 20 minutes, and the observational period lasted in total 8 months in 3 deployments of 2-3 months, beginning 28 September 2007 and ending 19 June 2008.

The meteorological and the waves conditions were obtained from "Puertos del Estado" WANA model calibrated with data obtained from the Llobregat buoy of the XIOM ("Generalitat de Catalunya"). In addition, vertical hydrographic profiles were made monthly using a SBE 25 CTD, coupled with a Seapoint turbidimeter. Water samples were collected during each cast near the bottom and at the surface. To obtain time series of suspended sediment concentration (SSC), turbidity sensors were calibrated with estimations of SSC measured from filtered water samples.

This paper analyses the data recorded during the high-energy season, from the 28th of September to the 29th of November 2007, at the three tripod locations (20 m, 30 m and 40 m). During this first deployment, there were six moderate storms with significant wave height (Hs) of about 2-3 m and peak wave period (Tp) around 10 s, increasing during the strongest storm to Hs up to 3 m and a Tp of 12 s (Figure 2).

The highest near-bottom current speed at the three locations were associated with storms events, reaching maximum values up to 25 cm/s. During those events, the mean component of the near-bottom currents was 1-2 orders of magnitude higher alongshelf than across-shelf with a resultant flow predominantly directed towards the SW.

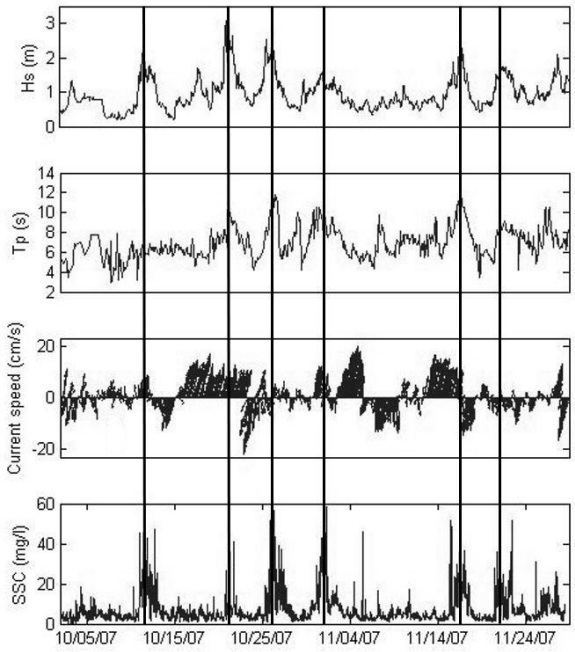


Fig. 2. Time series of significant wave height (Hs), peak wave period (Tp), near-bottom current vectors and SSC (0.6 mab) at 20 m depth during the high wave-energy period. Vertical lines identify the six resuspension events.

The near-bottom SSC during the recorded period showed a high temporal and spatial variability, and mean values decreased offshore. At 20 m depth, the SSC was less than 0.5 mg/l during fair-weather conditions and increased up to 50 mg/l during storms (Figure 2). Finally, regarding to the sediment flux, the mean alongshelf sediment fluxes at all the recording sites were higher than the across-shelf component and decreased with increasing depth.

Acknowledgments This work was funded by the Spanish Ministry of Science and Technology within the SEDMET project (CTM2006-06919).

References
1 - Guillén, J., Jiménez, J.A., Palanques, A., Gràcia, V., Puig, P., Sánchez-Arcilla, A., 2002. Sediment resuspension across a microtidal, low-energy inner shelf. *Cont. Shelf. Res.*, 22: 305-325.
2 - Palanques, A., Puig, P., Guillén, J., Jiménez, J., Gràcia, V., Sánchez Arcilla, A., Madsen, O., 2002. Near-bottom suspended sediment fluxes on a river-influenced, tideless fetch-limited shelf (the Ebro continental shelf, NW Mediterranean). *Cont. Shelf. res.*, 22 (2): 285-303.

USE OF GEOCHEMICAL FEATURES TO IDENTIFY CHANGES IN RECENT SEDIMENTATION ON SEAMOUNTS OF THE DJIBOUTI BANKS AREA (NW ALBORAN BASIN)

N. López-González [1]*, D. Palomino [1], J. T. Vázquez [1], P. Bárcenas [2], V. Díaz Del Río [1] and L. M. Fernández-Salas [1]

[1] Instituto Español de Oceanografia, Centro Oceanografico de Malaga, Puerto Pesquero s/n, 29640 Fuengirola, Malaga, Spain - nieves.lopez@ma.ieo.es

[2] Departamento de Analisis Matematico, Facultad de Ciencias, Universidad de Malaga, Campus de Teatinos, 29080 Malaga, Spain

Abstract

The geochemical features in surficial sediments on seamounts of the Djibouti Banks allow determining a boundary between two sediment groups which fits with the seamounts summit break. The differences between these groups seem to be related not only with a physiographic limit but also with the influence of bottom currents, external inputs and geochemical processes.

Keywords: Sediments, Geochemistry, Trace Elements, Alboran Sea

Introduction and oceanographic setting

Changes in sediment features on seamounts can be related with both source and oceanographic conditions, but also geochemical interactions can be involved once particles are settled or along the water column. In order to ascertain the relation of those processes with the geochemical composition of recent deposits, a group of 28 sediment grab samples have been analyzed on two seamounts of the Djibouti Banks area (NW Alboran Basin). The studied seamounts are Avempace and Djibouti that show a tabular configuration at top with both tectonic and volcanic origin. The water masses involved in this area are the salty and dense Mediterranean water and the lighter Atlantic surficial water, which mixing process causes valuable effects on the geochemical transference between dissolved and particulate phases.

Results and discussion

Studied sediments are sandy mud and muddy sand with sand-sized foraminifera and ostracoda tests that also include variable amounts of glauconite grains. Neither heavy minerals nor quartz grains are observed in quite amount, what implies the sediment origin is mainly related to authigenic, pelagic and dust sources. Rare earth elements (REE) are quite sensitive to environmental changes. In order to evaluate the length of the fractionation along the series (Fig. 1), they have been normalized by Shale [1]. It can be observed an increase on $(La/Yb)_{Shale}$ index with depth as a result of the progressive enrichment of Light REE (LREE: La to Gd) that it is not showed by Heavy REE (HREE: Tb to Lu). This is due to the preferential removal of LREE by adsorption and/or scavenging onto clay-sized Al-bearing minerals. Otherwise, HREE are preferentially retained in solution as consequence of the formation of steady carbonate-ion complex in seawater [2] and almost do not show variation with depth, except if any external input is involved. In this latter case a possible Sahara dust input could enhance the Yb concentration observed in the sediment, but further studies are required to find the right relationship with this source.

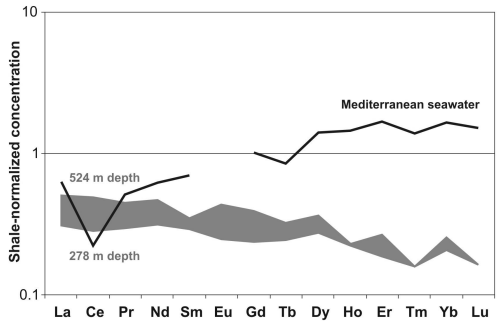


Fig. 1. Range of REE-Shale normalized pattern for sediment (ppm) with depth and average Mediterranean seawater (pmol kg^{-1}) [3].

Additionally, the depth evolution of selected elements has been studied in order to be used as geochemical proxies of sediment origin. The relation of Fe/K and Ca/Sr with depth (Fig. 2) show two main depths related to glauconite formation from foraminifera tests. Those depths are around 300 and 380 m for Djibouti and Avempace, respectively, and imply a low sedimentation rate on both summits. It is also in good agreement with the minimum content of lithogenic elements (Al, Li, Th, V, Ti) observed in the sediment composition that later increase with depth as a consequence of the phyllosilicate dominance on deep water sediments. This could be related with sedimentary inputs coming from bottom currents of Mediterranean origin that somehow prevent biogenic deposition at the slope of the seamounts.

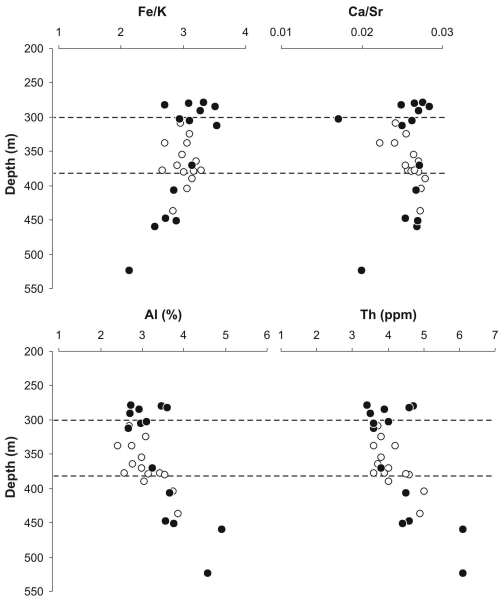


Fig. 2. Geochemical features of sediments with indication of the depth boundary (dashed line) where main changes occur on Avempace (open dot) and Djibouti (black dot) seamounts.

Conclusions

Preliminary results suggest a change on geochemical features in sediments deposited around 300 and 380 m depth for Djibouti and Avempace, respectively, that approximately fits with the physiographic summit break of both seamounts. According to this boundary two different sediment groups can be identified in recent deposits on the Djibouti Banks area. Shallower sediments are depending on geochemical reactions along the water column and biogenic deposition, while deep water sediments could be related with Mediterranean bottom currents and external inputs of Sahara dust.

References

1 - Piper D.Z., 1974. Rare Earth Elements in the Sedimentary Cycle: A Summary. *Chem. Geol.*, 14: 285-304.

2 - Sholkovitz E.R., Landing W.M. and Lewis B.L., 1994. Ocean particle chemistry: the fractionation of rare earth elements between suspended particles and seawater. *Geochim. Cosmochim. Acta*, 58: 1567-1579.

3 - Tachikawa K., Roy-Barman M., Michard A., Thouron D., Yeghicheyan D. and Jeandel C., 2004. Neodymium isotopes in the Mediterranean Sea: Comparison between seawater and sediment signals. *Geochim. Cosmochim. Acta*, 68: 3095-3106.

MUD BRECCIAS AND HEMIPELAGIC DRAPES OF MUD VOLCANOES FROM THE WEST ALBORAN BASIN: GEOCHEMICAL AND MINERALOGICAL CHARACTERIZATION.

Carmina López-Rodríguez [1]*, Maria Carmen Comas [1] and Francisca Martínez-Ruiz [1]
[1] Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Universidad de Granada, 18002, Spain - carmina@ugr.es

Abstract
Mud volcanoes from the West Alboran Basin were first discovered and surveyed during several TTR cruises. Provenance and nature of the mud breccias extruded by the Alboran mud volcanoes have been investigated by using geochemical and mineralogical proxies. This study presents preliminary results obtained from the analyses of mud breccia and pelagic drapes from gravity cores collected at different mud volcanoes (Perejil, Dhaka, Carmen and Maya). Mineralogical analyses showed a clay dominant composition of mud breccias, and major and trace element composition have revealed potential differences in parental affinity.
Keywords: Alboran Sea, Mud Volcanoes, Geochemistry, Mineralogy

Mud volcanoes were first discovered in the West Alboran Basin (WAB) during the TTR-9 cruise, in 1999 [1] and further investigated during the following TTR cruises (TTR-12, TTR-14 and TTR-17). The mud volcano field is located in the inner part of the Gibraltar Arc, where the major sedimentary depocenter is recorded (up to 7km). Previous studies have proved that this depocenter matches with an extensive Mud Diapir Province, which feeds mud diapirism and associated mud volcanoes. The mud diapirs are formed by under-compacted shales and olistostromes from the lowermost marine sedimentary sequence early to middle Miocene in age, as show both seismic interpretations [2] and micropaleontological studies of the extruded materials [3]. In order to investigate the provenance and nature of the mud breccias extruded by the Alboran mud volcanoes, we have analyzed three gravity cores (MS283G, MS285G and MS419G) from the top of Perejil, Dhaka and Maya mud volcanoes respectively, and one (MS385G) from the flank of the Carmen mud volcano. Perejil MV is located in the northern whereas Dhaka, Carmen and Maya MVs are located in the southern of the Mud Diapir Province. All of them occur between 400m and 850m depth and they are showed as positive structures. However, their morphologies are variable, ranging from semi-circular to elongated; as well as size in high, from 25m to 90m and in diameter, from 120m to 1600m. Continuous samples were taken from the hemipelagic drapes in all mud volcanoes and every 2cm at the top of the mud breccias. The rest of the mud breccias were sampled every 5 or 10cm at 2cm intervals. Samples were processed for mineralogical and geochemical analyses and different techniques were used: X-ray Diffraction (DRX), Atomic Absorption (AA) and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). The analyzed cores evidence similar bulk mineral composition at the four studied MVs. However, differences in mineral abundances could suggest a major contribution of clays in the northern volcano field as shown by the clay content at Perejil MV. In contrast, MVs from the southern volcano field (Carmen and Dhaka MVs) show similar abundances in bulk mineral components, thus supporting similar source contribution. Maya MV shows mixed bulk mineral composition. Such differences between the northern and the southern fields are further supported by the composition of the clay mineral assemblages. Differences are found in the smectite and illite abundances, being the smectites the predominant clays at Perejil MV, while illite is more abundant in Carmen and Dhaka MVs, whereas Maya MV shows particular proportions of smectite and illite. Such dissimilarities allow us to suggest distinct composition and/or depth of the source feeding materials between the northern and the southern volcano fields [table 1].

Tab. 1. Bulk mineralogy and clay mineral assemblages in mud breccias from Maya, Carmen, Dhaka and Perejil mud volcanoes.

		MAYA MV	CARMEN MV	DHAKA MV	PEREJIL MV
BULK MINERALOGY	% Quartz	5-15	15-20	15-20	5-15
	% Calcite	<5-10	10-15	<5-20	<5
	% Clays	65-90	65-75	55-75	80-90
CLAY ASSEMBLAGES	% Smectite	40-75	30-40	25-40	55-70
	% Illite	10-50	40-55	20-60	20-30
	% Kaolinite+Chlorite	10-20	10-20	15-20	<5-10

The distribution of major and trace elements across the studied intervals resulted from a large number of processes. Typical detrital elements (Al, Si, K, Mg, Rb, Th and REE), which preserve the characteristic trace-element distribution of source rocks, show that mud breccias are not chemically homogeneous, because reported down core differences in detrital-element content from Perejil, Carmen and Dhaka MVs suggest potential differences in parental affinity as divergences in the relative contribution of the diverse source layers and depths. Oscillations in redox-sensitive elements (U, Mo, V, Cr, Ni, Pb and carbonate associated elements as Sr) are observed at about the same depth than those reported for detrital elements, which also support a potential link with the nature of the source materials. Further investigation in clay mineral transformations will be need, in order to verify a potential smectite transformation in relation with a different depth source. Statistical analyses and chemical index of compositional maturity is in progress to confirm the relationship between chemical composition and source materials of the muc breccia as well as the influence of fluid activity in diagenetic process.

References
1 - Comas, M.C., Soto, J.I., Talukder, A.R. and TTR-12 Leg 3 (Marsibal-1) Scientific Party, 2003. Discovering active mud volcanoes in the Alboran Sea (Western Mediterranean). *IOC Workshop Report No 187, UNESCO:* 14-16.
2 - Talukder, A.R., Comas, M.C. and Soto, J.I. 2003. Pliocene to recent mud diapirism and related mud volcanoes in the Alboran Sea (Western Mediterranean). *Geological Society of London, Special Publications,* v. 216; p.443-446.
3 - Sautkin, A., Talukder, A.R., Comas, M.C., Soto, J.I. and Alekseev, A. 2003. Mud volcanoes in the Alboran Sea: evidence from micropaleontological and geophysical data. *Marine Geology.* 195, 237-261.

3D PALAEOCHANNEL RECONSTRUCTION IN THE LAGOON OF VENICE THROUGH GEOPHYSICAL EXPLORATION

F. Madricardo [1]*, J. A. De Souza [2], S. Donnici [1], R. Serandrei-Barbero [1], I. Correa [2] and A. Lezziero [3]
[1] Istituto di Scienze Marine, Castello, 1364a, 30122,Venezia, Italy - fantina.madricardo@ismar.cnr.it
[2] Center of Studies in Coastal and Oceanic Geology, UFRGS, 91501-970 Porto Alegre, Brazil
[3] PHAROS sas, 30175 Venezia, Italy

Abstract
From 2003 to 2009 an extensive survey in a large area of the Venice Lagoon was carried out by means of acoustic techniques. The measurements were performed in extremely shallow water (up to 0.5 m). The acoustic data revealed the presence in the sediments of a complex network of buried palaeochannels and palaeosurfaces confirmed by numerous ground truth analyses carried out on the cores extracted in the area. In this note, a high spatial resolution sub-bottom mapping of the central Venice lagoon is presented.
Keywords: Lagoons, Geomorphology, Acoustics, Mapping

Introduction
The Lagoon of Venice is the result of natural processes and intense human activities that determined its morphological evolution. The shallowness of the lagoon environment (average depth of about 1m) has for long time prevented the use of acoustic methods in this area. However, recent studies demonstrated that the use of sub-bottom profilers can be very useful to describe different phases of the lagoon evolution ([1], [2], [3] and refs. therein). In this contribution, we present the results concerning ultra shallow water (<1m) acoustic survey in the central lagoon between the industrialised area of Marghera and the city of Venice. The aim of our work is to reconstruct the complex subbottom architecture of a very anthropized environment through a multidisciplinary approach using acoustic and environmental data.

Methodology
With this purpose, a high spatial resolution survey was carried out using a traditional 30 kHz ELAC echosounder (with vertical resolution of about 10 cm) together with a DGPS system. Given the complexity of the buried morphologies, a 50 m parallel line survey grid was carried out in south-north direction (fig. 1).

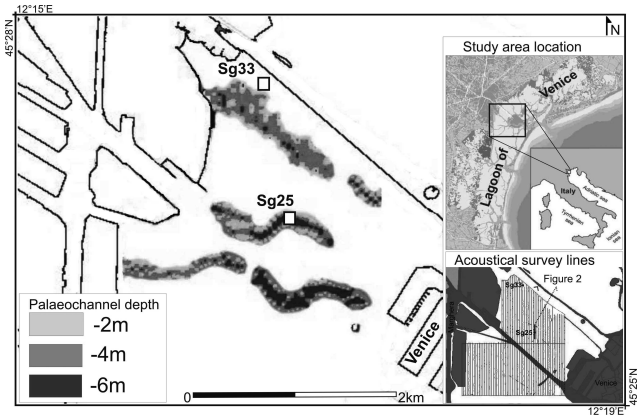


Fig. 1. Study area and acoustic survey line grid (on the right), quasi 3D palaeochannels reconstruction (on the left) and cores SG33 and SG25 position.

In correspondence with interesting acoustic discontinuities, several ground cores were extracted. Here, we present the results of the two cores SG25 and SG33, drilled inside and outside the palaeochannels, respectively.

Results and discussion
The high spatial resolution grid of the acoustic survey allowed a 3D reconstruction of three palaeochannels. Their meandering paths is presented in fig. 1, where, at the same time, the information about the palaeochannel acoustic signal depth is mapped. In particular, the central palaeochannel was intersected by the core SG25. The SG25 stratigraphic record presents mainly clayey-silty sediments from -1.2 to -5.2 m and sandy sediments from -5.2 to -6.60 m from the mean sea level (m.s.l). The ^{14}C dating taken at -5.2 m between the two facies allows the reconstruction of the palaeochannel shape of about 1600 ± 90 cal yrs BP (grey line in fig. 2). The inclined reflectors in the southern side of the acoustic profile correspond to the palaeochannel point bar migration. The grey line seems to separate two different phases: an earlier high energetic regime with sand deposition and channel migration and a later low energetic regime with a finer filling and apparently no migration. The two phases can be related to a change of the area hydrodynamics due to a climate worsening between the IV and VI century AD [4].

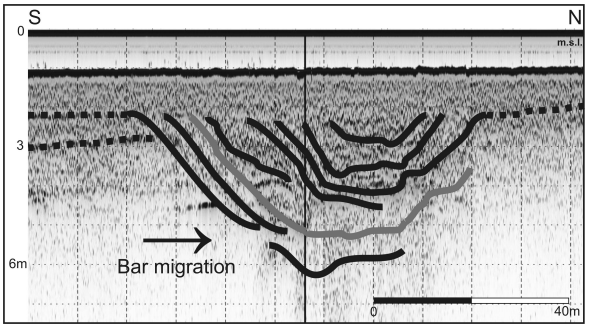


Fig. 2. Buried palaeochannel intersected by the core SG25 (black vertical line). The thick black lines show the channel point bar migration and stratification, while the dashed lines indicate palaeosurfaces. The grey line corresponds to the channel's shape about 1600 ± 90 cal yrs BP.

These palaeochannels probably incided the alluvial sediments, as, in this area, we found the lagoonal sediments down to about 2-3 m from m.s.l.. In particular, the core SG33 shows a transgressive sequence related to the expansion in historical age of the lagoonal margin over the mainland. This sequence is underlined by an environmental succession that goes from the alluvial to the high salt-marsh (at -1.47m) and, eventually, to the low salt marsh environment (at -0.77m m.s.l.).
This multidisciplinary approach allows for the first time a very detailed 3D reconstruction of palaeochannel paths and internal structures, of their meandering behaviour and of the palaeosurfaces evolution related to possible change of the central lagoon hydrology.

References
1 - McClennen, C.E., Housley, R. A., 2006. Late-Holocene channel meander migration and mudflat accumulation rates, Lagoon of Venice, Italy. *Journal of Coastal Research* 22: 930-945.
2 - Madricardo, F., Donnici, S., Buogo, S., Calicchia, P., Lezziero, A., De Carli, F., Boccardi, E., 2007. Palaeoenvironment reconstruction in the Lagoon of Venice through wide-area acoustic surveys and core sampling", Estuarine, *Coastal and Shelf Science* 75:205-213.
3 - Zecchin, M., Baradello, L., Brancolini, G., Donda, F. Pizzetto, F., Tosi, L., 2008. Sequence stratigraphy based on high-resolution seismic profiles in the late Pleistocene and Holocene deposits of the Venice area. *Marine Geology* 253: 185-198.
4 - Veggiani, A. 1994 I deterioramenti climatici dell'Età del Ferro e dell'alto Medioevo. *Bollettino della Società Torricelliana di Scienze e lettere*, 45: 3-80.

PRESENT-DAY REACTIVATION IN THE EASTERN IBERIAN AND BALEARIC MARGINS: MESSINIAN AS VERTICAL MARKERS.

Agnes Maillard [1]* and Christian Gorini [2]
[1] LMTG, University of Toulouse, 31400, France - maillard@lmtg.obs-mip.fr
[2] University of P. et M. Curie, Paris 6, France

Abstract
The offshore Eastern Spain and Balearic margin area is studied with seismic lines and bathymetric data. The aim of the study is to use the MSC markers (erosions and deposits) in order (1) to provide a complete scenario of the Crisis from land to deep basin and (2) to quantify the vertical movements and recent tectonics implications.
Keywords: Messinian, Tectonics, Balear Islands, Continental Margin

The Balearic area is located between two extensive basins, the Valencia Oligo-Miocene aborted rift to the North and the Algerian oceanic basin to the south. It is however the place of intense compressive activity as it has been affected by the Betic thrusts ([1], [2]), well known in the Ibiza and Mallorca Islands. The north of the Balearic promontory was during the Miocene a compressional front, whereas its southern border was the northern “passive or transform margin” of the Algerian basin ([3], [4]). From the Tortonian to now on, the northern edge of the Balearic promontory seems to have been affected mostly by extension. In southeastern Spain, the Western Internal Betics Ranges are actually affected by deformation like strike-slip, thrusts faults and uplift and by an important seismicity, as well as the adjacent Alboran Sea ([5], [6]). Between the Alicante Margin and the Ibiza Margin a strait connects the Valencia Trough and the Algerian Basin. An important work [5] studied the Present day deformation in the Alicante Region and showed a recent reactivation of the structures. Offshore, we show that the Eastern Margin of South Spain and south Balearic margin are also submitted to inversion. A dense net of seismic lines is used and the structural information is correlated with the very accurate multibeam maps that have been acquired [7] and show highs correlated to uplifted Miocene and/or Plio-Quaternary units. For example, a 650 m bathymetric high (150 m high relative to the surrounding seafloor, "El Cid" High) forms an E-W threshold between the La Nao Cape and Ibiza, also
observed by the seabeam map ([8]; figure 1).

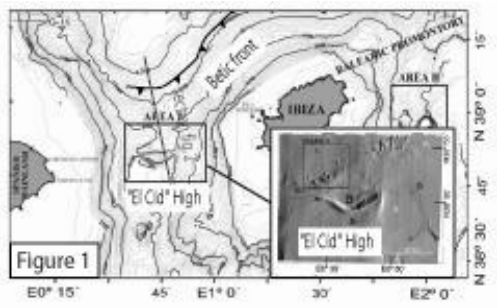


Fig. 1. Bathymetric map and sonar between the Eastern Spain and Ibiza Island, from [8].

The Messinian unconformity between Miocene and Plio-Quaternary units is well marked in the area (M on figure 2). It has been followed and mapped from the Valencia Basin to the Algerian Basin through the high Balearic area and is a precious chrono-stratigraphic marker of the end of the Miocene. The El Cid fold is E-W elongated, in that parallel to the Betic front. The Betic front clearly predates the actual deformation, as shown by the Messinian unconformity that sealed the deformation. Figure 2 shows the proximity of structures deformed before the Messinian Salinity Crisis (MSC) and structures deformed after. Uplift can be important as eroded Miocene units and even MSC units can reach the sea-floor. The MSC resulted in the Balearic promontory not only in erosions but also in thin depositional units (combination of clastic, fluvio-lacustrine sediments, reworked material and/or evaporites?) that can be compared to the ones deposited in the Valencia Basin [9]. Those thin deposits are distributed in several small basins between Valencia and Algerian Basins. An isobaths map of the base of the Pliocene units (Maillard et al., in prep) shows that the area is however shallower than the Valencia area. The MSC markers must thus record the recent tectonics that uplifted the area. The location of these basins should however question the relationship between deep basin evaporites and marginal evaporites. The studied area is well located because it records the MSC continuously from the land (evaporites in Salinas area, Bajo Segura Basin) to the deep basin, and from the intermediate depth basin (Valencia) to the deep basin (Algerian). The observations in this area provide a new basis to discuss not only the development of the MSC, but also the reconstruction of the uplifted and compressive structures in this area since 5 millions years. One important point is to understand how the compressional stress transmits from Algerian margin to Eastern Spain through the thinned continental crust of the Alboran Sea once, but also through, which is more complex, the Algerian oceanic crust.

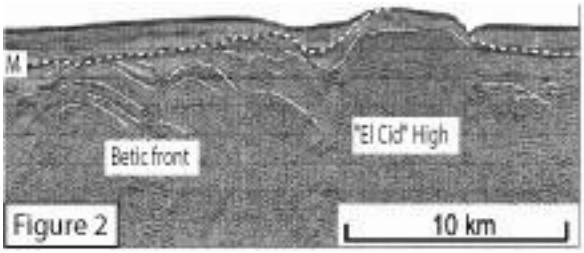


Fig. 2. Seismic line between the Eastern Spain and Ibiza Island showing the pre-MSC (Betic front) and post-MSC ("El Cid" high) deformation.

References
1 - Sanz De Galdeano, C., 1990. Geologic evolution of the Betic Cordilleras in the Western Mediterrarean , Miocene to the present day. Tetonophysics,,172, 107-119.
2 - Garcia-Duenas, V., Balanya, J.C. and Martinez-Martinez, J.M., 1992. Miocene extensional detachments in the outcropping basement of the Northern Alboran basin (Betics) and their tectonic implications. *Geo Marine Letters 12*, 88–95.
3 - Mauffret, A., Frizon de Lamotte, D., Lallemant, S., Gorini, C.and Maillard, A., 2004. E–W opening of the Algerian Basin (Western Mediterranean). Terra Nova 257–264.
4 - Acosta, J., Mun˜oz, A., Herranz, P., Palomo, C., Ballesteros, M., Vaquero, M., Uchupi, E., 2001a. Geodynamics of the Emile Baudot Escarpment the Balearic Promontory, Western Mediterranean. *Mar. Pet. Geol.* 128, 349– 369.
5 - Alfaro, P., Delgado, J., Estevez, A., Soria, J.M., Yebenes, A., 2002. Onshore and offshore compressional tectonics in the eastern Betic Cordillera (SE Spain). *Marine Geology* 186, 337–349.
6 - Sanz de Galdeano C. and Alfaro P., 2004. Tectonic significance of the present relief of the Betic Cordillera. *Geomorphology*, Volume 63, 175-190.
7 - Acosta, J., Canals, M., Lopez-Martinez, J., Munoz, A., Herranz, P., Urgeles, R., Palomo, C., Casamor, J.L., 2002. The Balearic Promontory geomorphology (western Mediterranean): morphostructure and active processes. *Geomorphology 49*, 177– 204.
8 - Acosta, J., Munoz, A., Herranz, P., Palomo, C., Ballesteros, M., Vaquero, M., Uchupi, E., 2001b. Pockmarks in the Eivissa Channel the western end of the Balearic Promontory (western Mediterranean) revealed by multibeam mapping. *Geo Mar. Lett. 21*, 123–130.
9 - Maillard A., Gorini C., Mauffret A., Sage F, Lofi J., Gaullier V. 2006. Offshore evidence of polyphase erosion in the Valencia Basin (Northwestern Mediterranean): scenario for the Messinian Salinity Crisis. In "The Messinian salinity crisis re-visited", Rouchy J.-M., Suc J.-P., Ferrandini J. edit., *Sedimentary Geology* 188-189, 69-91.

RE-CALIBRATING THE SR-ISOTOPE CURVE OF THE MESSINIAN SALINITY CRISIS IN THE MEDITERRANEAN

Vinicio Manzi [1]*, Stefano Lugli [2], Marco Roveri [1] and Rocco Gennari [3]
[1] Dipartimento di Scienze della Terra, Università degli Studi di Parma - vinicio.manzi@unipr.it
[2] Dipartimento di Scienze della Terra, Univeristà degli Studi di Modena e Reggio Emilia
[3] ALP - Alpine Laboratory of Paleomagnetism, Via Madonna dei Boschi 76, 12016 Peveragno (CN), Italy.

Abstract
Based on the age model put forward by the CIESM in 2008 a new Strontium ($^{87}Sr/^{86}Sr$) isotope curve for the Messinian salinity crisis (interval 6.5 Ma to 5.2 Ma) has been obtained plotting the available data from the literature and new data obtained from various regions of the Mediterranean area during the last years.
Keywords: Messinian, Stratigraphy, Geochemistry, Evaporites, Paleoceanography

Isotope geochemistry based on $^{87}Sr/^{86}Sr$ ratio have been used during the last decades to reconstruct the hydrological changes affecting the Mediterranean Sea during the Messinian salinity crisis ([1], [2], [3], [4]).
Unfortunately, the age models adopted for the calibration of these data appear not sufficiently accurate and not well stratigraphically constrained.

Following the new age model put forward by the CIESM consensus report ([5], [6]) and its successive refinements ([7], [8]) the strontium isotope data ($^{87}Sr/^{86}Sr$) available from the literature have been re-plotted, from 6.5 Ma to 5.2 Ma, together with new data obtained from various regions of the Mediterranean area during the last years.

According to the two-steps/three stage stratigraphic model ([5], [6]) the Messinian salinity crisis can be split into three main hydrological stages sharing different isotope trends.

Stage 1 (5.96-5.6 Ma)
The first stage, dominated by $CaSO_4$ evaporites, corresponds to the deposition of Primary Lower Gypsum (PLG). Most of the samples yield non-oceanic Sr isotope ratios with several exceptions that plot within coeval oceanic waters suggesting an evaporite basin dominated by continental waters that received significant marine recharges ([9]).
This stage was characterized by selenite precipitation in small and moderately deep (< 200 m), periodically oxygenated basins, and deposition of organic-rich, barren shales and dolostones in larger, deeper basins characterized by oxygen-depleted seafloors. Evaporite facies and isotope characteristics suggest precipitation from a relatively homogenous Atlantic-fed water body with a partially reduced outflow with a significant contribution of continental waters.

Stage 2 (5.6-5.55 Ma)
The second stage, mainly characterized by $CaCo_3$-NaCl-K salts, is characterized by a maximum Sr isotope data dispersion ranging from the global ocean field to lower values.
This phase marks the MSC acme and was triggered by a combination of pan-Mediterranean tectonic and climatic factors which caused a drastic reduction of the Atlantic connections and a possible short-lived blockage of the Mediterranean outflow, leading to salt and evaporitic carbonate precipitation during the TG14-TG12 interval.

Stage 3 (5.55-5.33 Ma)
The third stage, characterized by $CaSO_4$ evaporites, saw the deposition of the Upper Gypsum (UG) and Lago Mare sediments and is characterized by overall lower values of strontium isotope ratio than the coeval oceanic waters. Furthermore, the lower portion of this interval (Stage 3.1) is characterized by a depletion-upward trend, whereas the upper portion (Stage 3.2) is characterized by lower and less dispersed values.
UG selenite precipitation occurred from a large, residual water body only partially connected with the Atlantic. Surface waters sporadically undergoing progressive dilution due to a change in the precipitation regime and periodic inflow of evaporated continental waters. Tectonic quiescence and more generalized subsidence, also comprising the delayed effects of salt loading, were responsible for the progressive reestablishment of full connections with the Atlantic and the final Zanclean flooding.

References
1 - Flecker R. and Ellam R.M., 1999. Distinguishing climatic and tectonic signals in the sedimentary succession of marginal basins using Sr isotops: an example of Messinian salinity crisis, Eastern Mediterranean. *In*: Pedley H.M., Frostick Lynne (Eds),Unravelling tectonic and climatic signals in sedimentary successions. Geological Society of London. London, United Kingdom847-854.
2 - Flecker R. and Ellam R.M., 2006. Identifying Late Miocene episodes of connection and isolation in the Mediterranean–Paratethyan realm using Sr isotopes. *Sedimentary Geology*, 188-189, 189,203.
3 - McCulloch M.T. and De Deckker P., 1989. Sr Isotope constraints on the Mediterranean environment at the end of the Messinian salinity crisis. *Nature*, 342 (6245), 62-65.
4 - Mueller D.W. and Mueller P., 1991. Origin and age of the Mediterranean Messinian evaporites: implications from Sr isotopes. *Earth and Planetary Science Letters*, 107 (1), 1-12.
5 - CIESM, 2008. The Messinian Salinity Crisis mega-deposits to microbiology - A consensus report. *CIESM Workshop Monographs* 33, 73,82. Monaco.
6 - Roveri, M., Lugli, S., Manzi, V. and Schreiber, B.C., 2008. *T*he shallow- to deep-water record of the Messinian salinity crisis: new insights from Sicily, Calabria and Apennine basins. CIESM, 2008. The Messinian Salinity Crisis mega-deposits to microbiology - A consensus report. *CIESM Workshop Monographs*33, 73–82. Monaco.
7 - Manzi V., Lugli S., Roveri M. and Schreiber B.C., 2009. A new facies model for the Upper Gypsum (Sicily, Italy): chronological and palaeoenvironmental constraints for the Messinian salinity crisis in the Mediterranean. *Sedimentology*. doi: 10.1111/j.1365-3091.2009.01063.
8 - Manzi V., Lugli S., Roveri M., Schreiber B.C., Gennari R., *submitted*. The Messinian "Calcare di Base" (Sicily, Italy) revisited.
9 - Lugli S., Bassetti M.A., Manzi V., Barbieri M., Longinelli A., Roveri M. and Ricci Lucchi F., 2007. The Messinian "Vena del Gesso" evaporites revisited: isotopic and organic matter characterization. In B.C. Schreiber, S. Lugli and M. Babel (eds) "Evaporites through space and time", *Journal of the Geological Society*, 285, 143-154.

MINERAL PRECIPITATION BY *IDIOMARINA LOIHIENSIS* AND *MYXOCOCCUS XANTHUS*: IMPLICATIONS FOR THE BIOGEOCHEMICAL CYCLES OF CARBON AND BARIUM IN THE MEDITERRANEAN

F. Martinez-Ruiz [1]*, F. Morcillo [2], J. M. Arias [2], B. Fernández-Luque [2], C. De Linares [2] and M. T. González-Muñoz [2]
[1] Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Universidad de Ciencias de Granada, 18002, Spain - fmruiz@ugr.es
[2] Depto. Microbiología. Fac. Ciencias. Universidad Granada. Spain

Abstract
Microbial processes played a major role in mineral precipitation throughout the Earth's history. Such processes have been widely discussed for the last few decades with regard to carbonate precipitation. Other than microbial precipitation of carbonates, in natural environments is also of great interest the potential role of microbes in the precipitation of marine barite. Regarding carbonates, our experiments show how certain isolated bacteria from the Alboran Sea surface waters are able to precipitate different Mg-rich carbonates at modern marine seawater salinity. Ongoing work also focuses on bacterial precipitation of marine barite and its role in the biogeochemical cycle of barium and in the record of this element in Mediterranean paleoenvironments.
Keywords: Bacteria, Mineralogy, Alboran Sea, Sediments

Introduction
Microbial processes have played an important role mediating carbonate production throughout the Earth's history [e.g., 1]. In particular, precipitation of microbial dolomite has been the focus of extensive research [e.g., 2], being this mineral is of key importance for understanding biogeochemical processes and cycles in past and modern environments. Thus, understanding of the microbiogeochemical processes involved in the precipitation of Mg-rich carbonates is essential to further understand the dolomite production in ancient environments. In this context, recent experiments have revealed that Ca-Mg kutnahorite, a mineral with a dolomite-ordered structure, can also be precipitated by bacteria [3]. As for dolomite, precipitation of Ca-Mg kutnahorite has been mostly obtained in hypersaline bacterial culture experiments. However, our recent work has demonstrated that marine bacteria were also able to precipitate this mineral at modern marine seawater salinity [4]. In addition to the investigation of microbial processes in relation to carbonates and the carbon cycle, the investigation of the biogeochemical cycle of Ba is also of major importance since both cycles are closely related and Ba is considered and excellent proxy of past marine biological productivity. The mechanism by which barite precipitates in undersaturated seawater still remains unknown. Considerable research has focused on this element over the last decades, but living organisms that directly precipitate barite have not yet been identified in seawater. Nevertheless, a reasonable proposal would seem to be that bacteria could play a role in this process. As an initial approach to this hypothesis we carried out an experiment using *Myxococcus xanthus*, an abundant and ubiquitous heterotrophic soil bacterium, and it was demonstrated that this microorganism induced barite precipitation [5]. As myxobacteria are recognized mainly as soil bacteria, ongoing work is being focused on the role of marine bacteria in sulfate precipitation.

Materials and methods
For carbonate precipitation experiments, a bacterial strain, MAH1, has been isolated from a seawater sample collected from the Alboran sea surface waters. It has been characterized using polyphasic taxonomy as Gram-negative, growing between 2-43 ºC, heterotrophic, aerobic and required NaCl for growth. Results of phylogenetic analyses evidenced that the strain belongs to *Idiomarina loihiensis* species. For biomineralization experiments, the solid medium used was the marine medium (MM) (% w/v, yeast extract 0.5%, triptone 1%, purified agar-agar 2% in seawater from Alboran Sea, pH 7.6). For sulfate precipitation experiments, *M. xanthus* cells were inoculated on a solid culture medium with Ba (CM-Ba) (0.4% yeast extract, 2 mM $BaCl2 \cdot 2H2O$, 2% purified Difco agar-agar in distilled water). To recover the precipitates formed, a needle was used for the largest crystals, and the small ones were recovered by melting the solid medium in a microwave oven. After this, crystals were washed with distilled water to eliminate culture medium remains and cell debris. Precipitate composition and morphologies were studied by Scanning Electron Microscopy (LEO Carl Zeiss GEMINI-1530, coupled with energy-dispersive X-ray microanalysis). Precipitate mineralogy was determined by X-ray diffraction using a Bruker D8 Advance diffractometer.

Results and dicussion
The MAH1 produced Ca-Mg kutnahorite and struvite at seawater salinity conditions. In this case, the amino acid metabolism resulted in a release of ammonia and CO_2. Such release increased the pH and CO_3^{2-} concentration of the culture medium, creating an alkaline environment where saturation is reached and thus carbonate precipitation occurred. It has also been suggested that specific attributes of certain bacteria promote calcium carbonate formation [6]. Precipitation of carbonates may thus be related to heterogeneous nucleation on negatively charged bacterial superficial structures. Furthermore, the nature of the organic matrix determines which ion is preferentially adsorbed and, consequently, which mineral phase is formed. Bacterial carbonate precipitation could therefore be strain specific. In this sense, a significant characteristic of the *Idiomarina* genus is its uniquely high content in odd-iso-branched fatty acids, suggesting that this particular membrane characteristic could induce Ca-Mg kutnahorite production. In fact, this production is not related to the medium composition since other bacteria also cultivated in the MM medium did not produce this mineral. In this regard, the precipitation of Mg-Ca kutnahorite by the investigated *Idiomarina* strains strengthens the hypothesis that the precipitation of a carbonate with a dolomite-type-ordered structure also occurs in marine environments at standard salinity [4]. In the case of sulfate precipitation by *M. xanthus*, crystal growth evolves from spheres to aggregates in which barite crystals become visible. The initial phase is a P-rich precursor phase, which suggests that phosphoryl and carboxyl groups in the structural polymers of the cell wall outer membrane may be sorbent constituents, which play an important role in the precipitation process [5]. These results were the first to indicate that barite precipitates in bacterial cultures, and the results support the hypothesis that the origin of this mineral may be bacterially mediated. Such precipitation suggests that in marine environments, bacteria may enhance barite production by providing nucleation sites and by producing crystal growth. This is, however, only an initial approach for future investigation regarding the role of bacteria in the Ba biogeochemical cycle.

Acknowledgements: Projects CGL2007-61489 and CGL2009-07603 (MICINN); 200800050084447 (MARM), Projects RNM 3943 and 05212 (Junta de Andalucía).

References
1 - Wright D.T., Oren, A., 2005. Nonphotosynthetic bacteria and the formation of carbonates and evaporites through time. *Geomicrobiol. J.* 22: 27-53.
2 - Vasconcelos, C., Warthmann, R., McKenzie, J.A., Visscher, P.T., Bittermann, A. Van Lith, Y., 2006. Lithifying microbial mats in Lagoa Vermelha, Brazil: Modern Precambrian relics?. *Sediment. Geol.*, 185: 175-183.
3 - Rivadeneyra, M.A., Martín-Algarra, A., Sánchez-Navas, A., Martín-Ramos, J.D., 2006. Carbonate and phosphate precipitation by Chromohalobacter marismortui. *Geomicrobiol. J.*, 23: 1-13.
4 - González-Muñoz, M.T.; De Linares, C.; Martínez-Ruiz, F.; Morcillo, F.; Martín-Ramos, D.; Arias, J.M., 2008. Ca-Mg kutnahorite and struvite production by Idiomarina strains at modern seawater salinities. *Chemosphere*, 72,: 465-472.
5 - González-Muñoz, M.T.; Fernández-Luque, B.; Martínez-Ruiz, F.; Ben Chekroun, K.; Arias, J.M.; Rdríguez-Gallego,M.; Martínez-Cañamero, M. and Paytan, A., 2003. Precipitation of barite by Myxococcus xanthus: possible implications for the biogeochemical cycle of barium. *Appl. Environ. Microbiol*., 69: 5722-5725.
6 - Hammes, F., Boon, N., de Villiers, J., Verstraet, W., Siciliano, S.D., 2003. Strain-specific ureolytic microbial calcium carbonate precipitation. *Appl. Environ. Microb.*, 69: 4901-4909.

SEABED SEEPAGE IN THE MEDITERRANEAN SEA : WHAT DID WE LEARN FROM MULTIBEAM SWATH DATA AT DIFFERENT SCALES?

Jean Mascle [1]*, Stéphanie Dupré [2] and Benoit Loubrieu [3]
[1] CNRS UMR GEOZUR, Observatoire de la Côte d' Azur - jean.mascle@geoazur.obs-vlfr.fr
[2] Locean, UPMC, Paris, Fr
[3] Geosciences-Marines, Ifremer, Brest, Fr

Abstract

High-resolution swath data acquired using ship-borne and near-bottom multibeam systems have considerably increased our knowledge and understanding of active sea floor processes in the Mediterranean Sea. Swath mapping of large areas with ship-borne systems has revealed the regional distribution of seabed seepage structures in particular across the Eastern Mediterranean Sea deep-sea basins. Near-bottom multbeam data have revealed remarkable details of seabed features resulting from the expulsion of mud, fluid and gas. The latter data almost bridge the gap between ship-borne data and visual observations, and have been especially useful for planning in situ observations, measurements and sampling.

Keywords: Eastern Mediterranean, Swath Mapping, Mud Volcanoes

Multibeam seabed surveys conducted during the last decade in the Mediterranean Sea [1] have modified our understanding of the active geological and related biological processes that impact the seafloor of this oceanic space over time. One of the most spectacular results concerns the numerous seepage structures mapped and studied on the sea floor of the Eastern Mediterranean Sea, within two different tectonic settings: (a) tectono-sedimentary accretionary wedges (the Calabrian Arc and the Mediterranean and Florence rises) resulting from subduction of Africa beneath Europe [2] and (b) passive margin segments (particularly off northern Egypt) that have been the locus of huge sedimentary accumulations since Mesozoic times [3]. In this presentation, we briefly discuss and illustrate different types of data obtained using swath multibeam systems operated at different frequencies, and the potential level of interpretation they are providing to better image, study and understand the various fluid expulsion features and processes within the Eastern Mediterranean Sea. Multibeam systems provide two types of swath data: morpho-bathymetric data, and acoustic reflectivity (also often called backscatter or acoustic imagery). Swath data may be acquired using either ship-borne systems, typically located on research vessel's hull, or at much higher resolution using systems operating at near-bottom depths (10 to 50 m above the seabed), carried by Autonomous Underwater Vehicles (AUV) [4] or Remotely Operated Vehicles (ROV) [5] (Figure 1). - Swath bathymetric and acoustic imagery from ship-borne systems have allowed regional mapping of extensive fields of fluid escape structures, only some of which were previously known from either standard bathymetric mapping or discontinuous sonar studies. Compilation of data from numerous multibeam surveys [1] have provided regional maps at various scales (DTMs with pixel sizes ranging from 30-500 m depending on the area and the system used), which reveal the regional distribution of relatively large-scale features (a few hundred metres up to several km in diameter, and a few tens metres in elevation) such as mud volcanoes, mud flows, gas chimneys and caldera-like features [2,3]. These results have afforded insights into the relationship between seepage structures and the regional tectonic framework. For example, a clear link between back-thrusting and the distribution of mud volcanoes on the Mediterranean Ridge implies a fundamental role of tectonic lineaments as conduits for mud and fluid expulsion [2]. Similarly the non-random distribution of gas chimneys along the Egyptian continental margin may be explained by specific regional characteristics such as the presence or absence of underlying seals (Messinian salt deposits), the occurrence or lack of buried organic-rich deposits, and the re-activation of former fault zones [3]. In addition to regional mapping, ship-borne swath data have provided the necessary morphologic and acoustic backgrounds to better locate "in situ" studies of active fluid seepage using manned submersibles (e.g. the Nautile from Ifremer) [5] and/or ROVs (the Victor from Ifremer or the Quest from Marum) [4] - High-resolution swath data from near-bottom multibeam systems were first recorded over seabed seepage features in the Mediterranean Sea only 4 years ago (at least on the academic side). On the Egyptian continental margin, the first use of a multibeam system mounted on an Autonomous Underwater Vehicle (AUV) allowed the construction of morpho-bathymetric and backscatter maps with 1 m pixel resolution from mud volcanoes in water depths of 1200 m [4]. Elsewhere on the Egyptian margin, maps with pixel sizes of 30 cm have recently been obtained using a ROV over two active mud volcanoes in water depths of 3000 m. These data provide new insights into the functioning of fluid escape structures and facilitate in situ samplings and measurements at high accuracy. The acquisition of seafloor bathymetric and acoustic imagery of such high-resolution almost fills the gap in spatial scale between conventional ship-borne multibeam data and in situ direct or video observations made from submersibles or remotely operated vehicles.

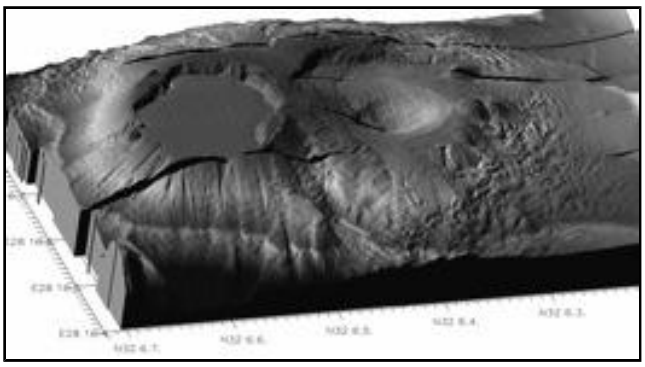


Fig. 1. 3D high-resolution bathymetry view of "Chephren" twin mud volcanoes (1m grid) by 3000 m water depth (Northern Egyptian Margin) acquired with a multibeam mounted on the Victor ROV and operated at 400 kHz.

References

1 - Loubrieu B., Mascle J., and Medimap group, 2007, Morpho-bathymetry of the Mediteranean Sea, *CIESM/Ifremer special publication.*

2 - Huguen C., Chamot-Rooke N., Loubrieu B., Mascle J., 2006, Morphology of a pre-collision, salt-bearing, accretionary complex: The Mediterranean Ridge (Eastern Mediterranean), *Marine Geophysical. Research*, 27, 61-75

3 - Loncke L., Mascle J., 2004, Mud volcanoes, gas chimneys, pockmarks and mounds on the Nile deep-sea fan (Eastern Mediterranean): Geophysical evidences, *Marine and Petroleum Geology*, 21,669-689

4 - Dupré S., Buffet G., Mascle J., Foucher J.P., Gauger S., Boetius A., Marfia C., the Aster^X AUV team, the Quest Rov team and the Bionil scientific party2008, High-resolution mapping of large gas emitting mud volcanoes on the Egyptian continental margin (Nile Deep Sea Fan) by AUV surveys, *Marine Geophysical Research*, 29, 275-290

5 - Foucher J.P., Westbrook G.K., Boetius A., Ceramicola S., Dupré S., Mascle J., Mienert J., Pfannkuche O., Pierre C., Praeg D., 2009, Structure and Drivers of Cold Seep Ecosystems, *Oceanography*, 92-109

HIGH-RESOLUTION SWATH MAPPING OF SUBMARINE LANDSLIDES ON THE NICE SLOPE (LIGURIAN SEA) BY AUV SURVEYS: IMPLICATION FOR GRAVITY-FLOW TRANSFORMATION

S. Migeon [1]*, A. Cattaneo [2], V. Hassoun [1], A. Dano [1], C. Larroque [1] and E. Ruellan [1]
[1] Géosciences Azur, Observatoire Océanologique, 06235, Villefranche sur Mer, France - migeon@geoazur.obs-vlfr.fr
[2] IFREMER BREST, Département Géosciences Marines, 29280, Plouzané, France

Abstract
The continental slope offshore the city of Nice was investigated in 2006 and 2009 using an AUV operating a multibeam EM2000 system. Abundant evidences of past and more recent failures were identified. Processes of flow transformation were also deduced from the changes of seafloor morphology suggesting that rapid processes of transformation of cohesive debris flows into turbulent flows occurred over short distance, less than 6-8 km downslope from the scars.
Keywords: Ligurian Sea, Swath Mapping, Sediment Transport, Deep Sea Processes

Submarine failures are probably the sedimentary process which has the strongest impact on the erosion, shaping and evolution of continental slopes through time. Large-scale failures of volumes exceeding several hundreds of km^3 are fortunately rare, with a return period of several thousands of years or more. Small-scale failures with volumes of several hundreds of m^3 are still difficult to detect using conventional geophysical tools but are probably much more common, as return periods of 5 years or less have been evaluated where repetitive surveys were conducted (Smith et al., 2007). Thus, repetitive small-scale failures could also have a strong impact on the evolution of continental slopes over a short time, and lead to the deposition of high-frequency turbidites in the deep basins.

For marine environments, valuable geohazards and risk assessments require the precise identification of the different types of slope instabilities and evaluation of their recent or past activity, recognition and discrimination between several pre-conditioning and triggering factors (Locat, 2001). Identification of potential areas where slope movements could be triggered requires data whith higher resolution than those classically used until now in marine geosciences researches. Similarly, return frequency and triggering factors of slope failures are usually deduced from the study of past and buried landslides. It is then speculated that return frequency and triggering factors of future, present-day and past landslides are similar, but without any certainty. To address the problems of small-scale morphology of failures, recent triggering of landslides and volumes of slope deposits that could be remobilised during a failure event, the continental slope offshore the city of Nice was mapped in 2006 and 2009 using an AUV (Autonomous Undersea Vehicle) operating an EM2000 multibeam system.

The Nice slope is a real natural laboratory to investigate submarine landslides and gravity-flow processes. Using classical EM300 bathymetry (spatial resolution of 25 m) collected in the frame of the MALISAR project, 150-200 scars with volumes less than 8×10^8 m^3 were identified on the continental slope from the shelfbreak to a water depth of 1200 m (Migeon et al., Soumis). The HR bathymetric data (spatial resolution of 2 m) collected on the NIce slope using the AUV during the AUVGEO and MALISAR4 cruises revealed a greater number of failure-related scars with several morphologies: some scars are themselves affected by retrogressive processes of erosion, suggesting failures were triggered a long time ago, while some scars are still steep with no evidence of post-failure erosion, suggesting they could have been triggered recently. Downslope from the scars, seafloor exhibits the presence of abundant blocs, 5-m high and 40-m wide as an average, then well-developed asymmetrical waves, 1-m high and 20 m in wavelength as an average. Such evolution could evidence the transformation of the deposits reworked in the scars into cohesive debris flows responsible for the transport of blocs of undisturbed sediment, then into turbulent flows responsible for the construction of the waves. Such transformation took place usually in less than 6-8 km. In the areas of the continental slope where AUV data were collected in both 2006 and 2009, changes of the seafloor morphology were always identified. They consist in the apparition of new sacrs 10-20-m high or in the refreshing of pre-existing scars. These observations reveal the failure processes on the NIce slope are still active over very short periods of time.

References

1 - Locat, J., 2001. Instabilities along ocean margins: a geomorphological and geotechnical perspective. *Marine and Petroleum Geology*, 18: 503-512.

2 - Migeon, S. et al., Soumis. Submarine failures off the French Riviera (northwestern Mediterranean): impact of sediment supply, tectonic and earthquakes. *Marine Geology*.

3 - Smith, D.P., Kvitek, R., Iampietro, P.J. and Wong, K., 2007. Twenty-nine months of geomorphic change in upper Monterey Canyon (2002-2005). *Marine Geology*, 236: 79-94.

INVESTIGATING THE ROLE OF MECHANISMS LEADING TO STAGNATING DEEP WATER IN THE EASTERN MEDITERRANEAN

Uwe Mikolajewicz [1]* and Fanny Adloff [1]
[1] Max-Planck-Insitut fuer Meteorologie, 20146, Hamburg, Germany - uwe.mikolajewicz@zmaw.de

Abstract
An ocean general circulation model is used to study the effect of several mechanisms that could have led to to stagnating deep water and thus formation of sapropels in the eastern Mediterranean.
Keywords: Paleoceanography, Circulation Models, Sapropel, Eastern Mediterranean

During the early Holocene, the Mediterranean circulation has undergone considerable changes. These changes are reflected in the occurrence of organic-rich marine sediment (called sapropels) in the eastern Mediterranean, which indicate the presence of oxygen depleted deep waters. The relative isolation of the basin together with a good coverage of available proxy data make this region an ideal test bed for modelling past climate changes.

The work presented here is a first step towards elucidating the mechanisms responsible for the formation of the sapropels. A regional version of the ocean general circulation model MPIOM (has been set up for the Mediterranean. This model was forced with daily atmospheric data derived from equilibrium time slice simulations with the global coupled atmosphere-ocean-dynamical vegetation model ECHAM5/MPIOM/LPJ (Mikolajewicz et al. 2007) for 9000 years before present. As the forcing data set has a length of 100 years, interannual as well as decadal variability are contained in the model forcing. The model derived river-runoff and ocean hydrography were used as additional forcings, the latter used as boundary condition at the Atlantic margin of the regional ocean model. Starting from homogeneous water, the model has been integrated for several centuries until a quasi-steady-state was reached. For the early Holocene, the runoff from the Nile is increased in comparison with present day conditions due to the enhanced African monsoon. The Bosphorus is assumed to be closed for this time period. These changes in freshwater input largely compensate each other in their effect on the upper-ocean salinity in the Levantine basin. The amplified seasonal cycle with reduced incoming short-wave radiation in winter leads to a general cooling. The enhanced summer warming is restricted to the uppermost layers. The model simulates the Adriatic as the main source of deep water for the eastern Mediterranean. Convection in the northern Aegean is strongly enhanced. Deep water ventilation rates show a marked decadal variability due to variations in the forcing. The obtained steady-state for 9000 years before present serves as baseline state for several perturbation experiments, which aim at elucidating potential mechanisms leading to stagnant deep water in the eastern Mediterranean. These experiments show that a sudden onset of an outflow from the Bosphorus or and or a sudden surface warming due to a reorganization of the Atlantic meridional overturning circulation are more effective to reduce the deep ventilation of the eastern Mediterranean, than a gradual freshening of the inflow from the Atlantic due to melting ice sheets. The vertical mixing reduces the effect of the initial perturbation and ventilation of the deep water slowly increases. An initial perturbation is sufficient to produce stagnant deep water for several centuries. In order to keep the deep water stagnant over several millennia, a strong initial perturbation needs to be combined with a weak, but permanently acting change forcing, e.g. the freshening due to the melting ice sheets.

References
1 - - Mikolajewicz U., Vizcaíno M. , Jungclaus J. and Schurgers G., 2007. Effect of ice sheet interactions in anthropogenic climate change simulations, *Geophys. Res. Lett.*, 34, L18706, doi:10.1029/2007GL031173.

INTRAANUAL VARIABILITY OF BIVALVIA ASSEMBLAGES IN THE TRANSITIONAL COMMUNITY OF DETRITC BOTTOMS OF THE NORTHERN ADRIATIC SEA

Vedrana Nerlovic [1]* and Ana Travizi [1]

[1] Ruder Boškovic Institute, Center for Marine Research, 52210, Rovinj, Croatia - vedrana.nerlovic@cim.irb.hr

Abstract

Present study is a part of comprehensive investigation of the soft bottom benthic communities in the northern Adriatic circalittoral zone. The goal of this study was to estimate intraanual dynamics of Bivalvia assemblages in the transitional community of detritc bottoms. Bivalvia assemblages structure was determined by the presence of 58 species, dominance of *Nucula nitidosa, Phaxas pellucidus, Tellina distorta, Thyasira flexuosa, Kurtiella bidentata*, and diversity ranged 19-31 species or 3,37-4,13 bits./ind. The results indicated abundant, diverse and stable community.

Keywords: Adriatic Sea, Bivalves

Introduction

The major part of the Adriatic Sea bottom belongs to the circalittoral zone and nearly all of the area of the mobile bottom is of the costal detritc type [1]. In this zone, variability of abiotic parameters is less pronounced than in the shallow infralittoral. Such environment support sustainable and stable benthic communities if strong environmental gradients and/or disturbance are not present. However, the northern Adriatic Sea is characterized by the full range of features associated with sensitive marine ecosystems, including temporary oxygen depletions [2, 3]. The community considered in this paper experienced heavy disturbance due to anoxia in 1989 [3, 4], but from that time severe oxygen crisis was not repeted [5]. Macrobenthic fauna and Bivalvia assemblages, in particular, are considered as very good indicators of ecocystem instability. In order to assess stability of transitional community of detritic bottoms, intraanual dynamics of Bivalvia assemblages was studied.

Materials and Methods

Bottom samples were collected with a 0,1 m^2 van Veen grab (five replicates) at sampling station SJ 007 (45° 17,0'N; 13° 16,0'E) in the northern Adriatic Sea from February 2003 to January 2004. This site is caracterized by depth 31 m and silty-sand type of sediment dominated by fine and very fine fractions [3]. Benthic biocoenosis is classified according Pérès and Picard [6] as transitional community of detritic bottoms [7]. The material was treated according to standard field and laboratory procedure: sieving (1 mm mesh), fixation (neutralized 4% formalin and 70 % ethanol), sorting and counting of macrofauna [8]. Collected bivalves were counted and identified to the species level [9]. The bivalve assemblage structure was analyzed with the PRIMER v. 5 software package [10].

Results and Discussion

A total of 58 species belonging to 25 families were recorded. Classification analysis based on Bray-Curtis similarity matrices separated three group of samples with moderate to high affinity (Q=53-75%), associated with higher (>15 °C), intermediate (10-15 °C), and lower near-bottom water temperatures (<10 °C), Fig. 1.

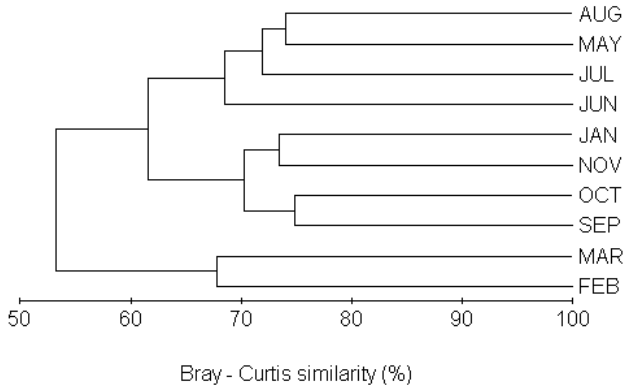


Fig. 1. Hierarchical classification of samples. The affinity level based on Bivalvia assemblages structure was expressed as % of faunistic similarity among months

The global ANOSIM test showed significant differences (R=0,186, p=0,1%) in assemblages structure between months but without a clear seasonal pattern (Tab. 1). In order to examine intraanual diversity changes, several univariate indices were calculated (S, d, J', H'). Statistically significant differences were found only for abundance values between March and May and for Shannon-Wiener diversity index between March and July, at p<0,05 level. Compared with results of previous study, provided at the same site in disturbed and unstable environmental conditions [3], this study revealed rather high values of univariate indices as well as its low intraanual variability. This investigation figured out rather abundant, diverse and stable Bivalvia assemblages with no clear seasonal distribution and thus, suport the hypothesis of sustainable and stable benthic community.

Tab. 1. Results of ANOSIM test (R=0,186, p=0,1%). Statistically significant differences between pair of months where indicated with asterisk (*).

	FEB	MAR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	JAN
FEB	-									
MAR	67,8	-								
MAY	66,8	63,2*	-							
JUN	66,4	62,9	69,9	-						
JUL	70,9*	64,2*	72,4	68,4	-					
AUG	60,0*	53,3*	74,0	70,9*	71,9	-				
SEP	57,9*	57,1*	61,6*	71,7	63,2*	71,1*	-			
OCT	57,0	56,4*	70,4	67,5	67,2	73,3	74,9	-		
NOV	61,1	57,0*	70,6	69,0	66,8*	65,3*	71,0	72,2	-	
JAN	63,9	60,4*	66,4*	72,8	68,1	69,4	70,3	73,8	73,4	-

References

1 - Gamulin-Brida H., 1967. The benthic fauna of the Adriatic Sea. Oceanogr. Mar. Biol. Ann. Rev., Harold Barnes, Ed.,George Allen and Unwin Ltd., London, 5: 535-568

2 - Stachowitsch, M., 1991. Anoxia in the northern Adriatic Sea: Rapid death, slow recovery. In: R. V. Tyson & T. H. Pearson (Eds.). *Modern and Ancient Continental Shelf Anoxia, Geological Society Special Publication* No. 58: 119-129.

3 - Travizi A., 1998. Recovery of meiofauna after anoxic stress. II Spatial distribution. *Period.biol*., 100: 71-79.

4 - Hrs-Brenko M., Medakovic D., Labura Z. and Zahtila E., 1994. Bivalve recovery after a mass mortality in the autumn of 1989 in the northern Adriatic Sea. Period. biol., 96: 455-458.

5 - Nerlovic V., Travizi A., 2006. Preliminary study on the Bivalvia assemblages of the northern Adriatic soft bottoms. 38th CIESM Congress / CIESM (ur.). Istanbul, 2007. 553-553

6 - Pérès J. M. and Picard J., 1964. Nouveau manuel de bionomie benthique de la mer Méditerranée. *Rec. Trav. Stat. Mar.* Endoume, 31: 137 p.

7 - Zavodnik D., Travizi A., Jaklin A., 1993. Phytoplankton bloom consequences on benthic organims. MAP *Tech.Rep.Ser*. 78: 91-121, UNEP, Athens 1994.

8 - Castelli A., Lardicci C. and Tagliapietra D., 2004. Soft-bottom macrobenthos. In: Gambi M.C., Dappiano M. (eds.), Biologia Marina Mediterranea, Mediterranean Marine Benthos: A Manual of methods for its sampling and study. S.I.M.B. Onlus, Genova, pp 99-131.

9 - Nordsieck F., 1969. Die europaischen Mearesmuscheln. Gustav Fisher Verlag Stuttgart, 256 p.

10 - Clark K.R. and Warwick R.M., 1990. Lecture notes prepared for the training of the statistical treatment and interpretation of marine community data. FAO/IOC/UNEP, Split 87 p.

LATE HOLOCENE CLIMATE VARIABILITY RECORDED BY MARINE-SEDIMENT COMPOSITION IN THE WESTERNMOST MEDITERRANEAN.

V. Nieto-Moreno [1], F. Martínez-Ruiz [1]*, S. Giralt [2], F. Jiménez-Espejo [3], D. Gallego-Torres [4], M. Rodrigo-Gámiz [1], T. Sakamoto [3], M. Bottchër [5], J. García-Orellana [6] and M. Ortega-Huertas [7]

[1] Instituto Andaluz de Ciencias de la Tierra (CSIC-UGR), Granada, Spain. - fmruiz@ugr.es

[2] Institute of Earth Sciences "Jaume Almera" (CSIC), Barcelona, Spain.

[3] Institute for Research on Earth Evolution, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan.

[4] Marine Geochemistry and Chemical Oceanography Department, Utrecht University, Utrecht, The Netherlands.

[5] Leibniz-Institut für Ostseeforschung, Warnemünde, Germany.

[6] Departament de Física, Institut De Ciència I Tecnologia Ambientals (ICTA), Bellaterra, Spain.

[7] Departamento de Mineralogía y Petrología, Facultad de Ciencias, Universidad de Granada, Granada, Spain.

Abstract

Rapid climate variability in the Western Mediterranean for the last 4000 years is reconstructed using high resolution marine sediments. Fluctuations in chemical and mineralogical sediment composition are linked to fluvial-eolian input and redox conditions coinciding with wet (Roman Humid Period, Medieval Warm Period) and dry (Little Ice Age, Late Bronze Age-Iron Age) periods. Such oscillations support the coupling of the Mediterranean climate with the North Atlantic climate system.

Keywords: Western Mediterranean, Alboran Sea, Paleoceanography, Geochemistry, River Input

Introduction

Although relatively more attention has been traditionally devoted to major climate changes during the last glacial cycle, the Holocene has also been punctuated by significant rapid climate variability including polar cooling, aridity and changes in the intensity of the atmospheric circulation [1]. During the Late Holocene (last 4000 years), the Medieval Warm Period (650-1150 cal. BP) and the Little Ice Age (150-650 cal. BP) have been the best identified climate fluctuations worldwide[2]. Previous work has revealed that Western Mediterranean is a highly sensitive area to abrupt forcing at millennial scales during the last glacial cycle ([3], [4]), supporting its link with the North Atlantic ocean-atmosphere system. The aim of this work is to reconstruct the paleoenvironment of the last 4000 yrs based on a multi-proxy approach that includes major and trace element-content and mineral composition of marine sediment records.

Material and methods

Two gravity-cores (305G, 306G) recovered during the Training Through Research Cruise 14, Leg 2, in the East Alboran Sea basin in 2004 have been selected. Both cores were sampled at 1 cm thick slices, to obtain a high resolution record of the last 4000 years. Samples were air-dried and homogenized to carry out mineralogical and geochemical analyses: X-Ray Diffraction, Transmission and Scanning Electron Microscopy, Atomic Absorption and Inductive Coupled Plasma-Mass Spectrometry. Grain size was also determined as a cumulative mass percentage using Sedigraph. The age-depth model has been based on six 14C-AMS dates performed on planktonic foraminifera (*Globigerina Bulloides*) extracted from the >125 μm fraction. Redundancy analyses of the datasets were carried out using the R software.

Results and discussion

Fluctuations of chemical and mineral composition of marine sediments coincide with significant Late Holocene climate oscillations. A decrease in fluvial-derived elements/minerals (e.g., Rb, detrital mica) occurred during the so-called Late Bronze Age-Iron Age and the Little Ice Age Period, while an increase is recognized during the Medieval Warm Period and the Roman Humid Period. This last trend is parallel to a decline of element/minerals of typical eolian source (Zr, kaolinite) with the exception of the Roman Humid Period when the Zr/Al ratio increases. Although barium has been proposed and used as a paleoproductivity proxy in the Mediterranean Sea at time of sapropel deposition, geochemical and statistical analyses show that during the Late Holocene, instead it provides information on detrital input, being associated with alumino-silicates. Furthermore, during this period, productivity reached low levels in relation to previous productive episodes (e.g. sapropels, Heinrich events). In fact, biogenic barite has not been detected in the studied cores. In the most recent sediments, an anthropic contribution is evidenced by a significant increase in the Pb content.

Acknowledgments: Projects CGL2009-07603, CTM2009-07715, CSD2006-00041(MICINN); 200800050084447 (MARM), Project RNM 05212, Research Group 0179(Junta de Andalucía) and Training-Through-Research Programme.

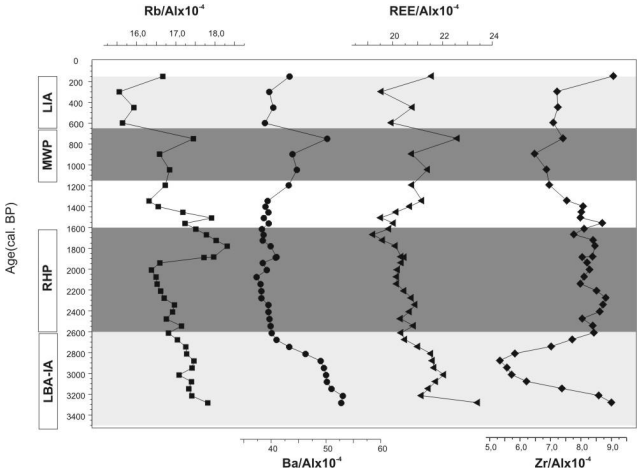


Fig. 1. **Detrital proxies from core 305G. Light grey bars indicate dry periods (LIA= Little Ice Age, LBA-IA= Late Bronze Age-Iron Age) and dark grey bars indicate humid periods (MWP= Medieval Warm Period, RHP= Roman Humid Period).**

References

1 - Wanner H., Beer J., Bütikofer J., Crowley T.J., Cubasch U., Flückiger J., Goosse H., Grosjean M., Joos F., Kaplan J.O., Küttel M., Müller S.A., Prentice I.C., Solomina O., Stocker T.F., Tarasov P., Wagner M. and Widmann M., 2008. Mid- to Late Holocene climate change: an overview. Quaternary Science Reviews, 27: 1791-1828.

2 - Jones P.D., Osborn T.J., Briffa K.R., 2001. The evolution of climate over the last millennium. Science, 292: 662-667.

3 - Cacho I., Grimalt J.O., Pelejero C., Canals M., Sierro F.J., Flores A. and Shackleton N.J., 1999. Dansgaard-Oeschger and Heinrich event imprints in the Alboran Sea paleotemperatures. Paleoceanography, 14: 698-705.

4 - Frigola J., Moreno A., Cacho I., Canals M., Sierro F.J., Flores J.A., Grimalt J.O., Hodell D.A. and Curtis J.H., 2007. Holocene climate variability in the western Mediterranean region from a deep water sediment record. Paleoceanography, 22: PA2209, doi:10.1029/2006PA001307.

MODÈLE MATHÉMATIQUE CONCERNANT LE TRANSPORT ALLUVIONNAIRE PAR LE DANUBE VERS LA MER NOIRE

Mihai Horia Oprica [1]*
[1] University politehnica of Bucharest, 060042, Roumanie - hoprica@yahoo.com

Abstract
On considère un modèle mathématique pour le transport alluvionnaire. Le modèle est basé sur l'équation de convection-diffusion de l'écoulement non permanent. Les équations sont intégrées numériquement à l'aide d'un schéma de différences finies.
Keywords: Water Transport, Models

Introduction
On présente un modèle mathématique pour le transport alluvionnaire en courant naturel dans différentes conditions. Parmi les processus impliqués dans ce phénomène, on prête une attention spéciale au transport alluvionnaire par l'eau courante et son interaction avec les sédiments de fond. Le modèle est basé sur les équations de Saint-Venant, caractéristiques du mouvement unidimensionnel non permanent des fluides à surface libre et l'équation de convection-diffusion.

Modèle mathématique concernant l'écoulement unidimensionnel non permanent avec la surface libre.
On applique les équations de Saint-Vénant :

$$B\frac{\partial z}{\partial t}+\frac{\partial^2 Q}{\partial x^2}=0$$

$$\frac{\partial Q}{\partial t}+\frac{Q}{A}\frac{\partial Q}{\partial x}-\frac{Q^2}{A^2}\frac{\partial A}{\partial x}+g\frac{n^2 Q|Q|}{AR^{4/3}}+gA\frac{Q}{A}\frac{\partial z}{\partial t}+Vg=0$$

où : V – vitesse moyenne en section, g – accélération de la gravitation, A – surface de la section transversale, x – distance au long de l'écoulement, t – temps, z - côte de la surface libre, Q - débit qui passe par une section d'écoulement, B - largeur moyenne, R – rayon hydraulique, n – coefficient de Manning [1].
Les déversements en mer posent un important problème de pollution lié à l'accroissement local de la turbidité et au dépôt de sédiments sur le fond. La turbidité, associée à la concentration de particules solides en suspension, provoque une extinction plus rapide de la lumière solaire et une réduction de la synthèse chlorophyllienne.
Dans les mers peu profondes, on se limite généralement à l'étude de la concentration moyenne dans la colonne d'eau et de la concentration du dépôt sur le fond.
L'équation décrivant l'évolution de la concentration moyenne des suspensions est obtenue à partir des équations de dispersion tridimensionnelles par intégration sur la profondeur. La moyenne sur la profondeur des termes quadratiques de convection donne deux contributions : la première contient le produit des moyennes, la seconde, la moyenne du produit des déviations autour de la moyenne. Cette seconde contribution a une structure analogue à celle des tensions de Reynolds et les expériences montrent qu'elle est effectivement responsable d'une dispersion turbulente, mais souvent beaucoup plus intense. Cet effet porte le nom "d'effet cisaillant" [2] parce qu'il est lié à l'existence d'un gradient vertical de vitesse. Il a été décrit par de nombreux auteurs dans des conduites, des canaux ou des estuaires. Dans ces cas, l'effet cisaillant apparaît après intégration sur toutes sections droites de l'écoulement et se traduit par un terme de dispersion longitudinale dans une équation de diffusion unidimensionnelle. Le mécanisme de diffusion est essentiellement bidimensionnel et les modèles établis pour diffusion doivent être généralisés [3].
Les particularités de l'équation de dispersion (présence de dérivées croisées et du terme de sédimentation, dominance des termes d'advection) imposent l'utilisation d'une méthode numérique spéciale [4] et [5].

Résultats et Discussions
Dans le cas du fleuve Danube, le cours entre Tulcea et la Mer Noire, les débits liquides varient entre 5 000 m^3/s et 12 000 m^3/s, tandis que les débits solides entre 10 kg/s et 22 kg/s. Le diamètre granulaire varie entre 74 et 100 micromètres. Dans l'évaluation des résultats, on a tenu compte du relief du lit du Danube, de la granulométrie, ainsi que d'autres paramètres hydrauliques (vitesses d'écoulement, pente hydraulique, coefficient de Maning, rayons hydrauliques des sections tranversales données). Les résultats théoriques concordent avec les observations accumulées lors des campagnes d'observation organisées dans le cadre d'un programme national roumain sur l'environnement.

References
1 - Cunge A., Holly Jr. F.M., Verwey A., 1980. Practical aspects of computational river hydraulique. Pitman Publ.Ltd. London
2 - Nihoul J.C.J., Deleernijder E. and Djendi S., 1989. Modeling the general circulation of shelf seas by 3D-k models, Earth Science Reviews, 26, 163-189
3 - Hancu S., s.a., 1985. Hidraulica aplicata. Simularea numerica a miscarii nepermanente a fluidelor, Editura Tehnica, Bucuresti, pp 307-349
4 - Oprica M.H., Georgescu I.I., Borcia C.M., 2001. On a mathematical model transport and tranfer of radionuclides Danube river, Romanian sector. 36th CIESM Congress Proceedings, pp. 203
5 - Beckers J.M., 1991. Application of 3D model to the Western Mediterranean. Journal of Marine Systems,1, 315-334

IRON AND MANGANESE SPECIES IN THE REDOX ZONE IN TWO DIFFERENT BASINS WITH ANOXIC CONDITIONS: THE BLACK SEA AND THE OSLO FJORD

Svetlana Pakhomova [1]* and Evgeniy Yakushev [2]
[1] P.P.Shirshov Institute of Oceanology RAS, 117997, Moscow, Russia - s-pakhomova@yandex.ru
[2] Norwegian Institute for Water Research, NO-0349, Oslo, Norway

Abstract
The joint analysis of the data of iron and manganese species distributions (dissolved Fe(II) and Fe(III), dissolved Mn(II), dissolved bound Mn, particulate Fe and Mn) obtained in the Black Sea and the Oslo Fjord allowed to reveal the common features, that testify the similarity of the mechanism of the redox layer formation in these regions.
Keywords: Black Sea, Redox, Vertical Profile, Metals, Anoxia

Distributions of chemical parameters in the redox zone were studied in the Black Sea (northeast region, central and coastal parts) and Oslo Fjord (Bunnefjorden and Baerumsbassenget), during spring-summer 2008 and 2009. The specific features of the hydrochemical structure observed in the studied objects are summarized in Table 1.

Tab. 1. Parameters of Mn and Fe distributions in the redox zones of the Black Sea and the Oslo Fjord

	Black Sea		Oslo Fjord	
	Center	Periphery	Bunnefjorden	Baerumsbassenget
Main features	stable hydrophysical structure	enhanced mixing due to RIM current	flushing ones per several years	anoxygenic photosynthesis and river inflow
Depth, m max / redox interface	2100 / 70-90	500 / 140-155	160 / 80-90	31 / 16-23
Thickness of suboxic zone, m	10-17	0-12	14	1-6
c(Mn_diss)max, uM	8-9	7-8	8-10	4-4.6
c(Mn_part)max, uM	0.2-0.4	1-2	1.3-2.1	0.7-1
c(Mn_bound)max, uM	1.8	0.5	1	0.6
grad(Mn_diss)max, uM/m	0.55	0.4	1.1	5.5
c(FeII)max, uM	0.34	0.45	0.33	0.4-1.4
c(FeIII_diss)max, uM	0.08	0.05	0.03	0.04
c(Fe_part)max, uM	0.15-0.29	0.22-0.48	0.18-0.22	0.60-0.85
grad(FeII)max, nM/m	5-10	5	19	500

Iron and manganese species distributions and redox zone structure at all are very similar in the Black Sea and the Oslo Fjord/Bunnefjorden. The abnormality of the biogeochemical structure in the Baerumsbassenget can be connected with the influence of a river or/and anoxygenic photosynthesis, because this redox interface is in a very shallow position, about 20 m. The suboxic zone in this fjord has a reducing character [1].

Our investigations demonstrated that Mn bound in stable complexes with hypothetically organic matter or pyrophosphate is observed in the redox zones in significant concentrations (up to 2 uM) [2], and is likely presented by Mn (III), an intermediate product of Mn(II) oxidation. On the base of the recent data obtained in the 100th cruise of RV "Professor Shtokman" (March-April, 2009) it was found that the bound Mn could exist in two forms – colloidal (0.02-0.40 um) and truly dissolved (<0.02 um) that perhaps results from complexing with different types of ligands. Bound Mn in colloidal form amount to 50-90% of total bound Mn in coastal and central parts of the Black Sea respectively.

Redox interfaces are characterized by a formation of a so-called "phosphate dipole" with a minimum above the sulfidic boundary and a maximum just below, with a steep increase in concentrations between the two. The hypothesis that P and Mn cycles are interconnected by the formation of complexes between Mn (III) and P-containing ligands can explain the presence of the shallow phosphate minimum above the sulfide-interface [2, 3]. The presence of the deep phosphate minimum (below the sulfidic boundary) is probably due to the formation of P-containing iron particles [4]. This dipole structure serves as a geochemical barrier that decreases the upward flux of phosphate from the anoxic layer.

Modeling results shown that exactly manganese cycle (formation of sinking down Mn(IV) and presence of dissolved Mn(III)) is the main reason of oxygen and hydrogen sulfide direct contact absence [3]. The model experiments enabled the role of a number of factors (amount of Mn, intensity of mixing, sinking rate, anoxygenic photosynthesis) to be assessed [1]. We suggest that in nature all the factors analyzed are not constant and can vary from region to region and from time to time. Their exact combination results in the shape of the distributions of the observed parameters.

References
1 - Yakushev E.V., Pakhomova S.V., Sorensen K., Skei J. 2009. Importance of the different manganese species in the formation of water column redox zones: observations and modeling. *Mar. Chem.*, in press. doi:10.1016/j.marchem.2009.09.007.
2 - Pakhomova S.V., Rozanov A.G., Yakushev E.V. 2009. Dissolved and particulate forms of iron and manganese in the redox-layer of the Black Sea. *Oceanology*, 49: 773-787.
3 - Yakushev, E.V., Pollehne, F., Jost, G., Umlauf, L., Kuznetsov, I., Schneider, B., 2007. Analysis of the water column oxic/anoxic interface in the Black and Baltic seas with a Redox-Layer Model. *Mar. Chem.*, 107: 388-410.
4 - Dellwig, O., Leipe, T., Glockzin, M., Marz, C., Pollehne, F., Schnetger, B., Yakushev, E.V., Brumsack, H.-J., Böttcher, M.E. 2009. A new particulate Mn–Fe–P-shuttle in the water column of anoxic basins. *Geochim. Cosmochem. Acta.* Submitted.

MONITORING THE FLOW AND THE PHYSICAL PROPERTIES OF A SUBMARINE GROUNDWATER DISCHARGE IN MESSINIAKOS GULF (SOUTHERN GREECE).

Vassilis P. Papadopoulos [1]*, Aristomenis P. Karageorgis [2], Dimitris Georgopoulos [2] and Evagelos Papathanassiou [2]
[1] Hellenic Centre for Marine Research, Local Office of Achaia - vassilis@ath.hcmr.gr
[2] Hellenic Centre for Marine Research, Institute of Oceanography, 19013, Anavyssos, Greece

Abstract
We present the first obtained time series of a monitoring project studying a submarine groundwater discharge (SGD) in Kalogria Bay, Greece. During a previous survey in the area, salinities ~1-2 were detected. The emerging flow and the physical characteristics of the upwelling water are recorded by means of a rotor flow meter and a CT probe. Both were deployed on a metallic frame which was placed at the sea bottom inside a karstic cavity. Salinity values between 20 and 36 have been recorded, indicating a brackish water outflow during the dry season of the year (July-October 2009). The water outflow exhibited velocities ranging from 8 to 28 cm/sec.
Keywords: Salinity, Monitoring, Brackish Water, Eastern Mediterranean

Submarine groundwater discharges (SGDs) are detected in many coastal areas on a global basis and today they are recognized as important factors of land-ocean interaction, with potential socioeconomic benefits [1]. In the Mediterranean Sea, they are traced mainly along coasts with karstic structures within the inland coastal zone [2]. In December 2006, an expedition carried out on board the R/V AEGAEO of the Hellenic Centre for Marine Research, visited the eastern Messiniakos Gulf coasts around the Kalogria-Stoupa marine area (SW Peloponnissos). A CTD probe, carried by a diver inside a submarine karstic cavity, where groundwater discharged, recorded salinities ~1-2 at a water depth of ~25 m. The low salinity encouraged a monitoring project in prospect of exploitation of the discovered fresh water. In July 2009, a flow meter (model Sensordata 6000), and a conductivity-temperature (CT) recorder (model SBE-37) were deployed, attached on a stainless-steel frame close to the sea bottom inside the cavity. The instrumentation is scheduled to be recovered for

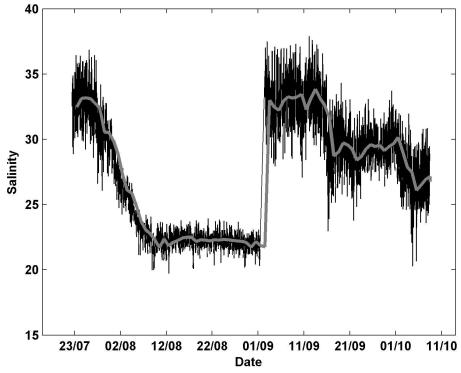


Fig. 1. Salinity fluctuation near the disharge point.

maintenance and data uploading from time to time, usually at monthly intervals. Figure 1 shows salinity variations during the first two deployments, from 22 July 2009 to 8 October 2009. The main feature observed is the relatively high salinity values, when compared against the value of salinities ~1-2, which were recorded in December 2006. Salinities fluctuate between 20 and 36, accompanied by a persistent high frequency oscillation with an amplitude range between 2 and 6. Another characteristic is that the oscillation amplitude is fluctuating proportionally with the salinity. As salinity values decrease, the oscillation amplitude is apparently reduced. We can also observe the remarkable jump in salinity values between the recovery and redeployment of the CT probe on the 1st of September (Fig. 1). This sudden rise could be primarily attributed to the very low discharge of the SGD (dry period, summer-early autumn), which results in an extremely unstable turbulent regime around the discharge point, and secondly to a possible slight different position of CT probe after the redeployment. The latter could be related to a possible rotation of the frame, and a consequent slight increase of the distance from the water discharge point. Another possible explanation could be attributed to external factors associated with the local circulation patterns. The coastal sea current may drive the upward flow and cause a declination from the vertical direction. Such persistent sea currents prevail at times in Messiniakos Gulf with their maximum speed occurring near the coastline [3]. However, still this jump remains unclear, since the temperature variation does not exhibit a similar behavior, but a normal transition between the 1st and the 2nd deployment period. Contrary to salinity, temperature follows a normal fluctuation with the highest values of 24-26 ^{o}C occurring during the last days of August. The strong turbulence also affects the temperature variation with a constant oscillation amplitude of 2-4 ^{o}C. As far as it concerns the flow measurements, the values recorded during the first few days of the deployment, they were between 20-27 cm/sec. Unfortunately, an instrument malfunction truncated the first deployment period to a total length of only 4 days (30 minutes interval). To ensure a total coverage of the deployment period during the second deployment, a pair of flow meters were installed on the frame, one at the same position as the previous, and another one exactly at the base of the frame. The latter covered the period from 2 to 15 September 2009, and the span of useful data was limited to the half of the deployment period due to a blockage of the rotor by a coarse sand grain with a diameter of 1-2 mm. During that period, upward water flow velocity ranged from 18 to 24 cm/sec, with an ascending trend during the last days of recording. In order to extend the recording period, the upper flow meter was set to take measurements at a time interval of 3 hours. This flow meter provided a useful period of flow velocity records until 30 September 2009, with velocities strongly fluctuating between 8 and 28 cm/sec. A spectral analysis performed to the flow measurements highlighted both diurnal and semidiurnal peaks of the power spectral density. This is expected, as in general the SGDs can be modulated by the prevailing tidal regime [4]. In summary, the obtained monitoring data demonstrate a strongly turbulent and unstable SGD, regulated by the geomorphologic (karstic) structure of the coastal zone and modulated by factors as the local yearly precipitation cycle and the tidal regime. Continuous monitoring of the SGD will reveal in detail, the annual cycle of the discharged water velocity, volume, and salinity variations, since they are the crucial parameters for the potential exploitation of the outflowing water. In summary, the obtained monitoring data demonstrate a strongly turbulent and unstable SGD upflow, regulated by the geomorphologic (karstic) structure of the coastal zone and modulated by factors as the local yearly precipitation cycle and the tidal regime. The monitoring of the SGD will reveal in details, the annual cycle of the upward flow and the salinity fluctuation since they are the crucial parameters for exploiting the upwelling water.

References
1 - Taniguchi M., Burnett W.C., Cable J.E. and Turner J.V., 2002. Investigation of submarine groundwater discharge. *Hydrological Processes* 16 (11): 2115-2129.
2 - Fleury P., Bakalowicz M., and de Marsily M., 2007. Submarine springs and coastal karst aquifers: a review. *J. Hydrol*. 339: 79-92.
3 - Papadopoulos V.P., Vamvakaki Ch. and Renieris P., 2008. Eulerian measurements in the inner part of Messiniakos Gulf (South Ionian Sea) during 2007-2008. *Proceedings of the 9th Panhellenic Symposium on Oceanography and Fisheries*, 13-16 May, Patras, Greece.
4 - Holliday D., Stieglitz T.C, Ridd P.V. and Read W.W., 2007. Geological controls and tidal forcing of submarine groundwater discharge from a confined aquifer in a coastal sand dune system, *J. Geophys. Res.* 112: C04015.

METHANE-RELATED CARBONATES FROM COLD SEEPS OF EASTERN MEDITERRANEAN AND MARMARA SEA

C. Pierre [1]*, M. Blanc Valleron [2], I. Bouloubassi [1], N. Cagatay [3], J. Foucher [4], P. Henry [5], J. Mascle [6] and T. Zitter [5]
[1] Université Pierre et Marie Curie- LOCEAN - catherine.pierre@locean-ipsl.upmc.fr
[2] MNHN-CR2P
[3] Istanbul Technical University
[4] Ifremer-Centre de Brest
[5] Université Aix-Marseille-CEREGE
[6] Geoazur, Villefranche-sur-mer

Abstract
Active methane seeps are present at the sea floor in the Eastern Mediterranean and Marmara Sea. The flow rate, temperature and chemistry of venting fluids differ largely from one site to another, depending on the source and depth of fluids. We present here the mineralogical and stable isotope compositions of carbonate crusts and concretions that were precipitated at or close to the sea floor and have registered the great variability of the fluids from the Mediterranean Ridge, Nile Deep Sea Fan and Marmara Sea cold seeps.
Keywords: Bacteria, Eastern Mediterranean, Marmara Sea, Deep Sea Processes, Mud Volcanoes

Active cold seeps in the Eastern Mediterranean were described since years 80's and their study was completed by deep-sea observations and sampling during oceanographic cruises using submersibles (MEDINAUT in 1998, NAUTINIL in 2003, MEDECO in 2007). In the Marmara Sea, cold seeps were observed in 2002 during the MARMARASCARPS cruise with ROV dives [1] and they were sampled using the submersible Nautile during the MARNAUT cruise in 2007. A few articles refer to the carbonate crusts from the MEDINAUT and NAUTINIL cruises [2],[3],[4].

Methane-rich fluids venting at sea-floor through geological structures as mud volcanoes, pockmarks and faults support specific chemosynthetic ecosystems where the microbial communities are particularly active in the carbon and sulfur cycles. The most important microbial process involved in these environments is the Anaerobic Oxidation of Methane (AOM) that is coupled with Bacterial Sulfate Reduction (BSR). During this process, the methane contained in the advected fluids is oxidized by the sulfate ions provided either by diffusion from bottom seawater or by advection of sulfate-rich brines.

The overall reaction describes the transfer of oxidized and reduced carbon and sulfur components:

$3CH_4 + 3SO_4^{2-} + Ca^{2+}$ ---> $3HS^- + CO_2 + HCO_3^- + 4H_2O + CaCO_3$

Carbonate and sulfide minerals are the two most important by-products of this reaction; their mineralogy may vary, depending on the cations and metal elements that are available in the fluids. Calcium carbonates (aragonite, calcite and magnesian calcite) dominate, especially in the upper sediments whereas magnesium-rich and iron-rich carbonates (dolomite, ankerite, siderite) increase progressively at depth.

The oxygen and carbon isotopic compositions of the diagenetic carbonates display very wide ranges that define three groupings :

1] The Mediterranean Ridge: the carbonate crusts are characterized by $\partial^{13}C$ values mostly in the range from -15 to -30‰ and more rarely down to -45‰; they include the highest $\partial^{18}O$ values (from 2.4 to 7.1‰).

2] The Nile Deep Sea Fan : the carbonate crusts display generally lower $\partial^{13}C$ values than the previous grouping, from -25 to -41‰; the range of $\partial^{18}O$ values is relatively narrow (2.4 to 4.8‰), except rare outlier lower values (-0.5 to 1‰).

3] The Marmara Sea : the carbonate crusts show the largest range of $\partial^{13}C$ values from -13 to -47.6‰ ; the range of $\partial^{18}O$ values is shifted to negative values (3.6 to -2.1‰).

The very low $\partial^{13}C$ values of diagenetic carbonates at all cold seep sites confirm that they are methane derived; the close association of carbonate with pyrite in the diagenetic crusts as well as biomarker proxies indicate that AOM was operating in conjunction with BSR.

The $\partial^{18}O$ values of carbonates mostly reflect isotopic equilibrium with the present-day bottom sea water; the heaviest $\partial^{18}O$ values from the Mediterranean Ridge are explained by the contribution of 18O-rich fluids originating from clay mineral dehydration at great burial depth; the lowest $\partial^{18}O$ values are due either to high heat flow in Amon mud volcano or to the contribution of brackish fluids in the Marmara sea.

References

1 - Zitter T.A.C., Henry, P., Aloisi, G., Delaygue, G., Cagatay, M.N., Mercier de Lepinay, B., Al-Samir, M., Fornacciari, F., Tesmer, M., Pekdeger, A., Wallman, K., and Lericolais, G., 2008. Cold seeps along the main Marmara fault in the Sea of Marmara (Turkey), *Deep Sea Research Part 1*, 55, 552-570.

2 - Aloisi G., Pierre C., Rouchy J-M., Foucher J-P., Woodside J. and the MEDINAUT Scientific Party, 2000. Methane-related authigenic carbonates of eastern Mediterranean Sea mud volcanoes and their possible relation to gas hydrate destabilisation. *Earth and Planetary Science Letters*, 5675, 1-18.

3 - Bouloubassi I., Aloisi G., Pancost R., Hopmans E., Pierre C., and Sinninghe Damste J. S., 2006. Archeal and bacterial lipids in authigenic carbonate crusts from eastern Mediterranean mud volcanoes. *Organic Geochemistry*, 37, 484-500.

4 - Gontharet S., Pierre C., Blanc-Valleron M-M., Rouchy J-M., Fouquet Y., Bayon G., Foucher J-P., Woodside J., Mascle J., and the NAUTINIL Scientific Party, 2007. Nature and origin of diagenetic carbonate crusts and concretions from mud volcanoes and pockmarks of the Nile deep-sea fan (eastern Mediterranean Sea). *Deep Sea Research II*, 54, 1292-1311.

THE CALABRIAN ARC SUBDUCTION SYSTEM: ACTIVE FAULTS, MUD DIAPIRISM AND THE GEOLOGICAL RECORD OF CATASTROPHYC EVENTS

A. Polonia [1]*, L. Torelli [2], F. Riminucci [1], L. Gasperini [1], M. A. Gutscher [3], F. Gallais [3], P. Mussoni [2], L. G. Bellucci [1] and L. Capotondi [1]

[1] ISMAR-Bo - alina.polonia@ismar.cnr.it
[2] University of Parma, Earth Science Dpt.
[3] Universite Européene de Bretagne, Brest

Abstract

The Calabrian Arc (CA) is part of the most active seismic belt in the Central Mediterranean region and it has been struck repeatedly by very strong historical earthquakes often associated with destructive tsunami. We addressed CA tectonics through an integrated geological/geophysical approach which has the potential to reveal if subduction is active, to map location and geometry of major faults absorbing plate motion, and to unravel relationships between tectonics, sedimentation and fluid flow in the accretionary wedge.

Keywords: Ionian Sea, Active Margins, Tectonics, Sedimentation, Seismics

The Calabrian Arc (CA) subduction complex connects the E-W trending Sicilian Maghrebian belt with the NW-SE trending Southern Apennines (Fig. 1) and develops along the African-Eurasian plate boundary in the Ionian Sea.

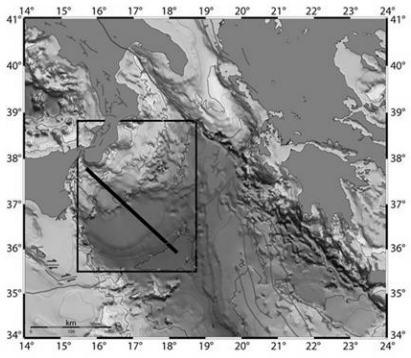


Fig. 1. Tectonic map of the study area with location of profile CROP M2B. Tectonic model from [1]. Seafloor bathymetry: GEBCO One Minute Grid.

At the toe of the CA, the thick sedimentary section of the African plate has been scraped off and piled up along thrust faults. This contributed to emplace a thick and about 300 Km wide subduction complex represented by a well developed accretionary wedge, multiple slope sedimentary basins and a seaward dipping continental backstop (Fig. 2). Although the regional architecture of the margin geometry has been described through the analysis of high penetration seismic data [2,3,4], some major questions are still debated: where is located the outer deformation front marking the Africa/Eurasia plate boundary? What is the location, nature and geometry of active faults absorbing plate motion? Are there evidences of the geological record of past catastrophic events in the subsurface?

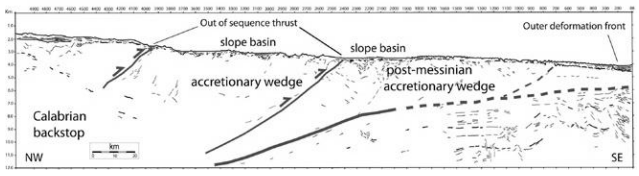


Fig. 2. Line drawing of pre-satck depth migrated MCS line CROP M-2B across the CA subduction system.

In order to address these issues we analysed in detail the structure and the evolution of the external CA through an integrated multi-scale geophysical approach that involves the combined analysis of multi-channel and single channel reflection profiles together with morpho-bathymetric data [5]. The interpretation of this multi-scale data-set represented the basis for a geophysical/geological cruise (CALAMARE cruise - Calabrian Arc Marine Geophysical Experiment) carried out in April-May 2008 with R/V CNR Urania [6]. We acquired geophysical (high resolution MCS reflection profiles and sub-bottom CHIRP) and geological data (gravity cores) in three key-areas selected through the interpretation of available data (outer and inner deformation fronts and the western lateral boundary of the subduction complex at the foot of the Malta escarpment). Sediment cores have been collected above morphological swells related to argilo-kinetic processes and within sedimentary basins in order to apply submarine earthquake geology in the CA and analyze the geological record of past catastrophic events in the subsurface. We collected well targeted sediment samples in tectonically controlled sedimentary basins to study the indirect effects of fault activity (i.e. mass wasting events, sand injections, turbidites, etc). Sediment cores from the Ionian abyssal plain and slope basins on the accretionary wedge have sampled turbidite sequences which likely contain a record of the great earthquakes or catastrophic events in the region. Radiocarbon ages will be obtained from monospecific planktonic foraminiferal samples above and beneath suspected seismic related deposits, while Pb210 and Cs137 radiocarbon dating will be applied to selected cores to resolve sedimentary structures associated with some recent events. If we will be able to make correlations between the sedimentary record (of earthquake-triggered submarine landslides or turbidites) and the earthquake catalogue in Southern Italy, we will try to extend the paleoseismic catalog further back in time. This approach has the potential to determine which portions of the arc have recorded catastrophic events in the past and which is the recurrence time of major events in the different regions of the subduction system. The lack of seismicity along the CA subduction fault plane (with a characteristic shallow dipping thrust-type focal mechanism) can mean either that subduction has ceased or that subduction is active but aseismic or locked. Diverse earthquake scenarios can be envisioned depending on which of these hypotheses is taken into account and the implication of each scenario for the hazard facing this region vary widely. The integrated analysis of the multi-scale geological/geophysical data-set acquired in the frame of the CALAMARE project has the potential to reconstruct CA active deformation and improve seismic risk assessment in the Central Mediterranean region.

References

1 - Morelli A. and Barrier E., 2004. Geodynamic map of the Mediterranean. Commission for the geological Map of the World, coordinated by Cadet J.-P. and Funiciello R.

2 - Finetti I., 1982. Structure, stratigraphy and evolution of the Mediterranean Sea. Boll. *Geof. Teor. Appl*., 15, 263-341.

3 - Cernobori L. et al., 1996. Crustal image of the Ionian basin an dits Calabrian margins. *Tectonophysics*, 264, 175-189.

4 - Doglioni et al., 1999. Foredeep geometries at the front of the Apennines in the Ionian Sea (central Mediterranean). *Earth Panet. Sc. Letters*, 168, 243-254.

5 - Polonia A., Torelli L., et al., African/Eurasian plate boundary in the Ionian sea: shortening and strike slip deformation in the outer Calabrian Arc accretionary wedge, 2008. GNGTS meeting, Trieste, pp. 37-40.

6 - Polonia A., et al., 2008. Rapporto sulla campagna CALAMARE-08; N/R CNR *URANIA*Napoli 2008-04-15 Bari 2008-05-12. URL:http://projects.bo.ismar.cnr.it/CRUISE_REPORTS/2008

EVIDENCE OF ACTIVE MUD VOLCANOES ON THE CALABRIAN ACCRETIONARY PRISM, IONIAN SEA

D. Praeg [1]*, S. Ceramicola [1], C. Pierre [2], J. Mascle [3], S. Dupré [2], A. Andersen [4], G. Bayon [5], I. Bouloubassi [2], L. Camera [3], A. Cova [1], G. De Lange [6], E. Ducassou [7], A. Freiwald [8], F. Harmegnies [5], D. Hebbeln [9], L. Loncke [10], V. Mastalerz [6], S. Migeon [3], A. Mostafa [11] and M. Taviani [12]

[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, 34010, Trieste, Italy - dpraeg@ogs.trieste.it

[2] LOCEAN, Université Pierre et Marie Curie, Paris, FR

[3] Géosciences Azur, Observatoire Océanologique, 06235, Villefranche sur Mer, France

[4] Station Biologique de Roscoff, FR

[5] Géosciences Marines, Ifremer, Brest, FR

[6] Utrecht University, 3508 TC Utrecht, Netherlands

[7] Université Bordeaux, FR

[8] Universität Erlangen-Nürnberg, DE

[9] Universität Bremen, DE

[10] Université de Perpignan, FR

[11] Alexandria University, Egypt

[12] CNR ISMAR, Bologna, 40129, Italy

Abstract

Multidisciplinary studies of mud volcanoes at two sites on the Calabrian Arc provide evidence of post-glacial eruptions, and of ongoing seabed seepage that supports 'hotspot' ecosystems. Mud breccias within gravity cores record at least one extrusive episode since the last glacial maximum c. 20 ka. Seabed investigations using ROVs document ongoing seepage of gas, at one of the sites associated with chemosynthetic ecosystems and with localized outflows of warm mud. Gas hydrates are theoretically stable on the Calabrian Arc and their post-glacial destabilization represents a possible driver of seabed extrusive and seepage activity.

Keywords: Eastern Mediterranean, Ionian Sea, Deep Sea Sediments, Mud Volcanoes

Mud volcanoes were discovered offshore southern Italy during the 2005 HERMES-HYDRAMED campaign of the Italian research vessel OGS Explora, which acquired the first regional multibeam coverage of the Calabrian accretionary prism [1]. Many possible seepage sites were recognised [see 2], of which two were proven to be mud volcanoes through the acquisition of multichannel seismic data and gravity cores containing mud breccias. Seabed investigations of these two sites were subsequently undertaken using remotely operated vehicles (ROVs) during campaigns of the r/v Meteor (M70/1, 2006) and the r/v Pourquoi pas? (MEDECO, 2007). In this presentation we summarise evidence for recent eruptions and ongoing seabed seepage.

The two investigated sites lie in water depths of 1600-2300 m on the inner and central Calabrian Arc. Within the inner Spartivento forearc basin, the Madonna dello Ionio comprises three MVs, twin cones each up to 140 m high and 1.5 km wide, and a caldera up to 3 km across. On the central thrust-fold belt, the Pythagoras MV is a single mud pie up to 9 km wide, rising up to 350 m above a seabed moat. Seismic data grids across both features show the seabed mud volcanoes to be the tops of extrusive edifices that extend over 1 km into the subsurface and interfinger with the flanking sedimentary succession above a regional unconformity of mid-Pliocene age, c. 3.5-3.0 Ma [3].

Recent extrusive activity is indicated by sediment cores from the Madonna dello Ionio and Pythagoras MVs that show oxidized mud breccias to lie near seabed, beneath a veneer of hemipelagic sediments. At the Madonna dello Ionio MVs, mud breccias have erupted since the last glacial maximum (c. 20 ka), based on radiometric dating and stratigraphic markers within the hemipelagic sediments. In the caldera at the head of the Madonna, mud breccias are overlain by sediments dated to c. 15.5 ka, and appear correlative to a mud breccia lens in a nearby core 1 km from the edge of the caldera. A younger extrusive episode may be recorded by mud breccias at the base of one of the twin cones of the Madonna which are overlain by marine sediments dated to c. 2 ka.

Seabed investigations using ROVs (video observations, geothermal probes, sediment and water samples) provide evidence of ongoing seepage. At both sites, bottom waters contain methane concentrations 100-200 times normal background levels. At the Madonna dello Ionio, all three MVs have elevated geothermal gradients, 2-20 times higher than adjacent areas, and fresh outflows of warm mud were observed on two of the MVs. The tops of all three MVs are otherwise characterized by a metre-scale relief comprising mud breccia flows mantled by hemipelagic sediments, the latter exhibiting intense bioturbation in the form of conical burrows; a 30 cm blade core contained chemolithotrophic tubeworms (polychaetes) and other fauna consistent with reduced conditions. At the Pythagoras MV, an area of chaotic seabed, with irregular relief developed in exposed mud breccias, suggests a recent and violent local extrusive episode.

Glacial-interglacial changes in sea level and bottom water temperatures suggest a possible climatic influence on mud volcanism. Gas hydrates are theoretically stable on the Calabrian Arc and their post-glacial destabilisation in response to warming bottom waters could provide a driving mechanism for recent eruptions and ongoing seepage.

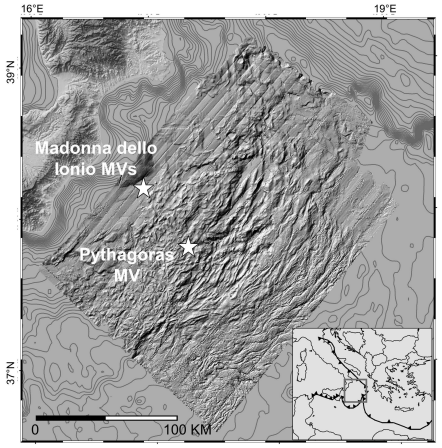


Fig. 1. Location of investigated sites of mud volcanism on the Calabrian Arc

References

1 - Ceramicola, S., Praeg, D. & the OGS Explora Scientific Party (2006). Mud volcanoes discovered on the Calabrian Arc: preliminary results from the HERMES-HYDRAMED IONIO 2005 campaign. *CIESM Workshop Monographs*, n. 29, p. 35-39

2 - Ceramicola, S., Praeg, D., Cova, A., Forlin, E., Diviacco, P., Centoze, J., Cotterle, D., Wardell, N. & Accettella, D. (this meeting). Exploring seabaed seepage features on the Calabrian accretionary prism. 39th CIESM Congress, Venice

3 - Praeg, D., Ceramicola, S., Barbieri, R., Unnithan, V. & Wardell, N. (2009). Tectonically-driven mud volcanism since the late Pliocene on the Calabrian accretionary prism, central Mediterranean Sea. *Marine and Petroleum Geology*, **26**, 1849–1865

WESTERN MEDITERRANEAN RESPONSE TO RAPID CLIMATE VARIABILITY: THE EOLIAN INPUT RECORD DURING THE LAST 20.000 YEARS.

M. Rodrigo-Gámiz [1]*, F. Martínez-Ruiz [1], F. Jiménez-Espejo [2], D. Gallego-Torres [3], V. Nieto-Moreno [1], D. Ariztegui [4] and O. Romero [1]

[1] Instituto Andaluz de Ciencias de la Tierra, CSIC-Universidad de Granada, Granada, Spain. *Correspondence to: - martarodrigo@ugr.es

[2] Institute for Frontier Research on Earth Evolution, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan.

[3] Marine Geochemistry & Chemical Oceanography. Utrecht University. Budapestlaan. The Netherlands.

[4] Section of Earth & Environmental Sciences, Geneva University, Geneva, Switzerland.

Abstract

Climate variability for the last 20.000 years in the western Mediterranean Sea has been reconstructed using geochemical and mineralogical proxies. An excellent high-resolution record from the East Alboran Sea basin has been analyzed. Geochemical data have provided detailed information on paleoclimate conditions and have allowed to establish fluvial and eolian input oscillations during abrupt climate changes, as well as the paleoxigenation conditions at time of sediment deposition.

Keywords: Western Mediterranean, Alboran Sea, Deep Sea Sediments, Atmospheric Input, Geochemistry

Introduction

Eolian input from the Sahara and other arid regions surrounding the Mediterranean has provided a considerable amount of dust particles contributing to the terrigenous sedimentation [e.g., 1]. This contribution was especially significant during glacial times when the eolian dust into the atmosphere increased through intensified surface winds, lower surface humidity and enhanced desertification [2]. The high sedimentation rates from the westernmost Mediterranean provide excellent conditions for reconstruction of the eolian input record at very high resolution and in turn atmospheric response to climate variability.

Material and methods

A gravity core 293G (402 cm length), recovered in the East Alboran Sea basin during the cruise Training Trough Research 12 Leg 3 (Lat. 36´10.414N, Long. 2´26.071W, water depth 1840m) was chosen for this study. It contains hemipelagic sediments composed of homogeneous green-brownish mud with some shell fragments, foraminifera and bioturbated layers. A continuous sampling every 1.5 cm was carried out for the interval spanning the last 20 kyr. Radiocarbon ages and stable oxygen isotope record from planktonic foraminifera (*Globigerina bulloides*) have provided a detailed age model. Sediment samples were analyzed using X-Ray Diffraction, X-Ray Fluorescence and Inductively Coupled Plasma Mass Spectrometry.

Results and discussion

Preliminary results indicate that the Heinrich event (H1) has been a generalized cold and dry period as shown by high $\delta^{18}O$ values and increasing ratio of eolian input proxies such as Zr/Al, Ti/Al and Si/Al (Fig. 1). In addition, an increase in deep water ventilation points to the injection of large volumes of freshwater from melting iceberg that reached the westernmost Mediterranean, causing a weakened in the Mediterranean thermohaline circulation [3]. During the Bölling-Alleröd period (B-A), a stable trend in thermohaline circulation is evidenced by lower oxygen bottom conditions and the oxygen isotope record. Therefore, this warm and humid period has been characterized by a decrease in values of eolian detrital proxies, indicanting a weaker atmospheric circulation as also supported by pollen records from this region [4]. Geochemical proxies also evidence a particular atmospheric configuration during the Younger Dryas chronozone (YD). Variations in detrital proxies suggest an increasing fluvial activity at the onset of this period, which points to a coupling between the hydrological cycle and the cold atmospheric configuration due to enhanced sporadic rainfalls. More stable climate conditions characterized the Holocene that is also punctuated by significant climate fluctuations such as the 8.200 yr cold event.

Acknowledgements: This work has been funded by Projects CGL2009-07603, CTM2009-07715, CSD2006-00041 (MICINN); 200800050084447 (MARM), Project RNM 05212, Research Group 0179 (Junta de Andalucía) and Training-Through-Research Programme UNESCO-IOC/ MSU.

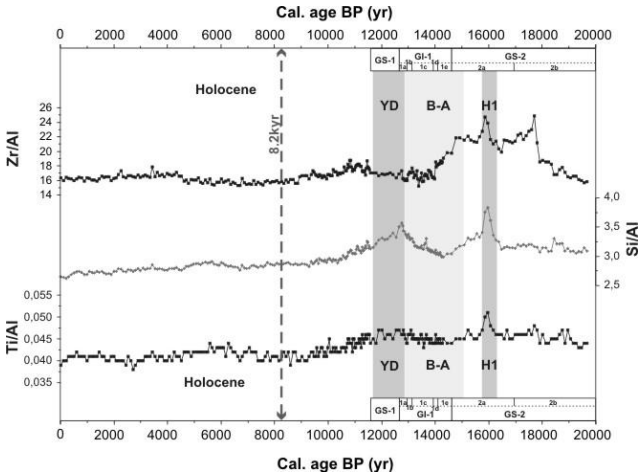


Fig. 1. Geochemical proxies profiles versus calibrated ^{14}C ages (Element/Al ratio for major elements and Element/Al ratio $*10^{-4}$ ppm for trace elements). Light grey vertical bar indicates the warm period Bölling-Alleröd (B-A) time interval. Dark grey bars indicate main cold periods, Younger Dryas (YD) and the Heinrich event (H1) time intervals. Very short dashed grey arrow indicates the "8.200 yr" cold event. Greenland Stadials (GS-1, GS-2) and Interstadials (GI-1) are indicated by white horizontal boxes.

References

1 - Loÿe-Pilot M.D., Martin J.M., 1996. Saharan dust input to the western Mediterranean: an eleven years record in Corsica. *In:* Chester R. (ed.), The impact of desert dust across the Mediterranean. Kluwer Academic Publ., Dordrecht, pp 191-199.

2 - Reader M.C., Fung I., McFarlane N., 1999. The mineral dust aerosol cycle during the last glacial maximum. *Journal of Geophysical Research-Atmospheres*, 104: 9381–9398.

3 - Sierro F.J., Hodell D.A., Curtis J.H., Flores J.A., Reguera I., Colmenero-Hidalgo E., Bárcena M.A., Cacho I., Frigola J., Canals M., 2005. Impact of Iceberg melting on Mediterranean thermohaline circulation. *Paleoceanography*, 20: PA2019. doi: 10.1029/2004PA001051.

4 - Combourieu Nebout N., Peyron O., Dormoy I., 2009. Rapid climatic variability in the west Mediterranean during the last 25.000 years from high resolution pollen data. *Climate of the Past Discussions*, 5: 671-707.

THE EASTERN MEDITERRANEAN RECORD OF THE MESSINIAN SALINITY CRISIS: NEW INSIGHTS FROM MARGINAL AND DEEP BASINS

M. Roveri [1]*, R. Gennari [2], S. Lugli [3], V. Manzi [1] and B. C. Schreiber [4]

[1] Dipartimento di Scienze della Terra, Università degli Studi di Parma - marco.roveri@unipr.it

[2] ALP Laboratory, Via Madonna dei Boschi 76, 12016 Peveragno (CN), Italy.

[3] Dipartimento di Scienze della Terra - Università degli Studi di Modena e Reggio Emilia Largo S. Eufemia, 19 - 41100, Modena, Italy

[4] Department of Earth and Space Sciences, University of Washington, PO Box 351310, Seattle Washington 98117, USA

Abstract

Based on a revisitation of the main outcropping Messinian successions on Cyprus, Zakynthos, Crete and of subsurface data from offshore areas, a preliminary stratigraphic model for the Eastern Mediterranean basin has been reconstructed and compared to the Western and Central Mediterranean basins.

Keywords: Messinian, Stratigraphy, Evaporites, Eastern Mediterranean

The Eastern Mediterranean record of Messinian events is mainly preserved in deep offshore basins. The limited and scattered Messinian outcrops of marginal basins offer a unique opportunity to find out a key for interpreting coeval offshore successions and thus reconstructing the development of the Messinian salinity crisis (MSC) of this area. This is a fundamental step for establishing the stratigraphic relationships between western and eastern Mediterranean Messinian units and testing the MSC two steps/three stages scenario recently put forward by CIESM [1], [2]. We focussed in particular on the Messinian successions of Cyprus and Zakynthos. A complete revisitation of Southwestern Cyprus Messinian basins (Polemi, Pissouri and Maroni/Psematismenos) led to point out that the local Lower Gypsum unit actually consists of clastic evaporites associated with subordinate gypsum cumulates deposited in very shallow depocenters, thus suggesting that only the second MSC step is here recorded (stages 2 and 3). The basal part of the unit usually comprises clastic carbonates ("*barre jaune*") containing resedimented selenite fragments formed during the first MSC step (PLG-Primary Lower Gypsum). This unit passes upwards to both stratified and/or chaotic gypsum-bearing clastic deposits. Gypsum cumulates commonly occur in the intermediate part of the unit; at Maroni the latter deposits show evidence for precipitation in very shallow water (bird tracks), but no clear desiccation features have been observed throughout the succession. We interpret these deposits as a shallow-water equivalent of the RLG unit (Resedimented Lower Gypsum), defined in western and central Mediterranean [1], [2] and recording the very short second MSC stage during which large volumes of halite and K-salts precipitated in deeper basins. These deposits are conformably overlain by the Upper Gypsum and Lagomare units which are very similar to their Sicilian equivalents [2], [3]. According to this interpretation, the base of the local Lower Gypsum unit is actually a regional unconformity corresponding to the Messinian erosional surface (MES) which can be traced downbasin in the offshore domain at the base of the deep basin evaporitic unit (Mobile Unit in [4], [5]). Halite is not preserved in this basin, but according to the regional scale considerations [6] it is possible that small lenses can be found included within the RLG unit. The Zakynthos Messinian succession shows a complex evaporite distribution largely controlled by synsedimentary compressive tectonics, very similar to what we have observed in the Northern Apennines and Sicily [2], [7], [8]. Step 1 Primary Lower Gypsum cyclically stacked selenites (PLG), cut on top by the MES and unconformably capped by thin paleosoil-bearing Lago Mare deposits, occur in shallow wedge-top basins (Kalamaki section); deeper depocenters formed in front of the main thrust fronts are characterized by the accumulation of thick clastic gypsum (RLG), also comprising displaced selenite blocks (Agios Sostis section). Subsurface data indicate that the RLG unit also contains thin lenses of halite developed in the more subsiding sectors of the basin(s) (K. Nikolaou, Hellenic Petroleum, 2009, pers. comm.). These results suggest that, like in the western and central Mediterranean areas, the eastern Mediterranean record of the 2nd MSC stage is characterized by the generalized dismantling of first step primary evaporites (PLG). This was probably triggered by tectonic activity coupled with sea-level falls during TG12-TG14 glacials which caused a concurrent short-lasting block of deep Mediterranean water outflow and the consequent widespread precipitation of halite in deeper basins and of gypsum cumulates in shallow marginal basins. However, the lack of evidence for desiccation in the latter settings suggests that the amplitude of the associated sea-level drop could have been considerably lower than the usually envisaged 1.5 km. A revisitation of available cores suggests that the evaporites included in the Upper Evaporites seismic unit in both western and eastern deep Mediterranean basins have mainly a clastic and subaqueous nature. Moreover, the high $^{87}Sr/^{86}Sr$ values of halite and/or anhydrite recovered from DSDP sites 374 and 376 suggest that, similarly to what observed for the Lower Evaporites, the usually envisaged correspondence between the seismically defined and the outcropping Upper Evaporites units is highly questionable. These data and observations result in a comprehensive MSC evolutive scenario based on more reliable stratigraphic correlations between marginal and deep basins across the western and eastern Mediterranean basins.

References

1 - CIESM, 2008. The Messinian Salinity Crisis from mega-deposits to microbiology - A consensus report. N° 33 in *CIESM Workshop Monographs* [F. Briand, Ed.], 168 pages, Monaco.

2 - Roveri M., Lugli S., Manzi V. and Schreiber B.C., 2008. The shallow- to deep-water record of the Messinian salinity crisis: new insights from Sicily, Calabria and Apennine basins. *In*: Briand F. (ed.), CIESM, 2008. The Messinian Salinity Crisis from mega-deposits to microbiology - A consensus report. *CIESM Workshop Monographs*, 33: 73–82.

3 - Manzi V., Lugli S., Roveri M. and Schreiber B.C., 2009. A new facies model for the Upper Gypsum (Sicily, Italy): chronological and palaeoenvironmental constraints for the Messinian salinity crisis in the Mediterranean. *Sedimentology*, available online.

4 - Lofi J., Deverchère J., Gaullier V., Gillet H., Gorin C., Guennoc P., Loncke L., Maillard A., Sage F., Thinon I., Capron A. and Obone Zue obame E., 2008. The Messinian Salinity Crisis in the offshore domain: an overview of our knowledge through seismic profile interpretation and multi-site approach. *In*: Briand F. (ed.), CIESM 2008. The Messinian Salinity Crisis from mega-deposits to microbiology - A consensus report. *CIESM Workshop Monographs*,33: 83–90. Monaco

5 - Hübscher C., Beitz M., Dümmong S., Gradman S., Meier K. and Netzeband G.L., 2008. Stratigraphy, fluid dynamics and structural evolution of the Messinian Evaporites in the Levantine Basin, Eastern Mediterranean Sea. *In*: Briand F. (ed.), CIESM 2008. The Messinian Salinity Crisis from mega-deposits to microbiology - A consensus report. *CIESM Workshop Monographs*,33: 97–105. Monaco

6 - Robertson A.H.F., Eaton S., Follows E.J. and Payne A.S., 1995. Depositional processes and basin analysis of Messinian evaporites in Cyprus. *Terra Nova*, 7: 233-253.

7 - Roveri M., Bassetti M.A. and Ricci Lucchi F., 2001. The Mediterranean Messinian salinity crisis: an Apennine foredeep perspective. *Sedimentary Geology*, 140: 201-214.

8 - Manzi V., Lugli S., Ricci Lucchi F. and Roveri M., 2005. Deep-water clastic evaporites deposition in the Messinian Adriatic foredeep (Northern Apennines, Italy): did the Mediterranean ever dry out? *Sedimentology*, 52: 875-902.

DEEP SEA HABITAT MAPPING AT THE SANT MARIA DI LEUCA COLD WATER CORAL PROVINCE: RESULTS FROM SMALL TO LARGE SCALE SEAFLOOR MAPPING AT ONE REPRESENTATIVE SITE

A. Savini [1]*, C. Corselli [1], B. Loubrieu [2], A. Vertino [3], J. Foucher [2], M. Fabri [4], A. Freiwald [5], K. Olu [2], J. Sarazzin [2] and M. Taviani [3]

[1] Dept. of Geological Sciences and Geotechnologies, Milano Bicocca University, 20126, Milano, Italy - alessandra.savini@unimib.it
[2] IFREMER BREST, 29280, Plouzané, France
[3] CNR Ismar Bologna, 40129, Italy
[4] IFREMER TOULON, 83507, La Seyne/Mer, France
[5] Universität Erlangen-Nürnberg, 91054, Erlangen, Germany

Abstract

The present work reports the main results obtained from a number of different acoustic and video investigations carried out at different spatial scales within the Mediterranean Santa Maria di Leuca (SML) Cold-Water Coral (CWC) province (south eastern Italy – northern Ionian Sea). The different scale of data sets here presented and discussed vary from small scale maps that resolve regional geomorphology of the Apulian plateau, to large scale maps provided for one representative site, where video-data, high resolution side scan sonar mosaic and micro-bathymetry well describe micro-scale variations in mound geomorphologic attributes and associated habitats.

Keywords: Geomorphology, Swath Mapping, Mapping, Ionian Sea, Biodiversity

Along the oceanic margin and in particular in the Mediterranean Sea, CWC distribution has been better known during the last decades thanks to the new technologies nowadays available for exploration in deep sea environments. The recent use of acoustic survey techniques and remotely operated vehicles (ROVs) revealed the presence of living CWC at different locations in the Mediterranean sea (i.e.: the Straits of Gibraltar [1], the Alboran Sea [2, 3], the Sicily Channel [4, 5], the Ionian Sea [5, 6, 7], and the Southern Adriatic Sea [5, 8]); although the Ionian Santa Maria di Leuca (SML) CWC province represents the largest occurrence of a living white coral community known in the Mediterranean so far. Several national and international oceanographic expeditions (e.g. the 2002 CNR COR2 cruise, the three cruises of the 2003-2005 Italian aplabes project, the 2006 CNR CORSARO cruise promoted by the cooperation between Euromargins/Eurocore 'Moundforce' ESF program, the 2006 METEOR M70 cruise and the 2007 MEDECO cruise of the EU 'Hermes' project) were initiated after the SML province's discovery, producing a number of different "seafloor mapping data". From these, three different scale of data sets are here presented and discussed: (1) a small scale morphobathymetric map (1/1000000) that resolve the regional geomorphology of the Apulian plateau; (2) a detailed medium scale morphobathymetric map (1/50000) obtained from multibeam data acquisition; (3) a large scale morphobathymetric map of one representative coral mound, where video-data, high resolution side scan sonar mosaic and micro-bathymetry have been collected. Small scale map (coming from the Gebco Digital Atlas) shows that the SML CWC province is located along the upper slope of the gently south-eastward dipping Apulian continental margin, the large-scale morphology of the area is related to a strong tectonic control. The multibeam data set collected between -300m and -1300m of water depth, over more than 900-km2 survey area, provided a detailed medium scale morphobathymetric map, in which several geomorphic processes are recognized, superimposed on the regional large-scale morphology [7]. In particular broad slope erosion, sediment sliding, block tilting and collapse and prominent downslope mass-movements were identified and drift sedimentation is also recognised along a central large ridge [6, 7]. Within this dataset CWCs are found along a depth belt between 500 and 900 m and in different physiographic settings, although they look to be abundant within the broad area affected by downslope mass-transport deposits [7], [9]. Here a detailed ROV-based survey, carried out in the framework of the Hermes project by the use of the VICTOR6000 ROV (MEDECO cruise – R/V Pourquoi Pas?), provided a high resolution mapping survey [10] at one representative seafloor feature identified as a coral colonised positive structure (coral-mound) during previous cruises. The relevant seafloor mapping data here presented, collected at different spatial scales, show how the large-scale mapped coral distribution and the mound morphology are well correlated to the environmental controls under which coral mounds can develop. These results also show how large scale maps can help in provide a proper assessment on CWC distribution along small scale maps and therefore show how such methodologies are essential to support deep-sea habitat mapping purposes, finding a way to extrapolate substrate maps into habitat maps based on acoustic proprieties.

References

1 - Álvarez-Pérez G., Busquets P., De Mol B., Sandoval N.G., Canals M., Casamor J.L., 2005. Deep-water coral occurrences in the Strait of Gibraltar. In: Freiwald, A., Roberts J.M. (Eds), Cold-Water Corals and Ecosystems. Springer, Berlin, Heidelberg, New York, pp. 207–221.

2 - Taviani, M., the CORTI & COBAS Shipboard Teams, 2004. Coral mounds of the Mediterranean Sea: results of EUROMARGINS Cruises CORTI and COBAS. 2nd EUROMARGINS Conference, Barcelona 11–13 November

3 - Lo Iacono C., Gracia E., Diez S., Bozzano G., Moreno X., Danobeitia J., Alonso B. 2008. Seafloor characterization and backscatter variability of the Almería margin (Alboran Sea, SW Mediterranean) based on high-resolution acoustic data. *Marine Geology*, 250 (1-2), 1-18

4 - Schembri, P.J., Dimech, M., Camilleri, M., Page, R., 2007. Living deep-water Lophelia and Madrepora corals in Maltese waters (Strait of Sicily, Mediterranean Sea). *Cahiers de Biolie Marine* 48,77–83.

5 - Freiwald, A., Beuck, L., Ruggeberg, A., Taviani, M., Hebbeln, D., 2009. The white coral community in the central Mediterranean Sea revealed by ROV surveys. Oceanography, 22(1), 58-74.

6 - Taviani, M., Remia, A., Corselli, C., Freiwald, A., Malinverno, E., Mastrototaro, F., Savini, A., Tursi, A., 2005. First geo-marine survey of living cold-water Lophelia reefs in the Ionian Sea (Mediterranean Basin). Facies. (50),409–417

7 - Savini, A., Corselli, C., 2010. High resolution bathymetry and acoustic geophysical data from Santa Maria di Leuca Cold Water Coral province (Northern Ionian sea–Apulian continental slope). *Deep-Sea Research II*, in press [doi:10.1016/ j.dsr2.2009.08.014].

8 - Trincardi, F., Foglini, F., Verdicchio, G., Asioli, A., Correggiari, A., Minisini, D., Piva, A., Remia, A., Ridente, D., Taviani, A. 2007. The impact of cascading currents on the Bari Canyon System, SW-Adriatic Margin (Central Mediterranean). *Marine Geology*, 246, 208-230.

9 - Vertino, A., Savini, A., Rosso, A., Di Geronimo, I., Mastrototaro, F., Sanfilippo, R., Gay, G., Etiope, G., 2010. Benthic habitat characterization and distribution from two representative sites of the deep-water SML Coral Mound Province (Mediterranean). *Deep-Sea Research II*, in press [doi: 10.1016/j.dsr2.2009.08.023].

10 - Le Guilloux E, Scalabrin C, Loubrieu B, Vangiresheim A, Chailloux C, Vertino A, Savini A, Sarazzin J, Olu K 2008. High-Resolution Habitat Mapping of Italian CWC Reefs: Results from ROV's Optical and Acoustic Survey Coupling. *Deep sea coral symposium 2008* – 4th ISDSC. Wellington, New Zeland, 1-5 Dicembre, 2008

TAPES PHILIPPINARUM (ADAMS & REEVE) HARVESTING EFFECTS ON SEDIMENT SETTLEMENT RATES AND EROSION PROCESSES IN THE LAGOON OF VENICE (ITALY).

Adriano Sfriso [1]*, Chiara Facca [1] and Sonia Ceoldo [1]
[1] Department of Environmental Sciences, University Ca' Foscari Venice - sfrisoad@unive.it

Abstract
Tapes philippinarum harvesting by means of mechanical and hydraulic dredging systems heavily affects the benthic habitats and the water column as huge amounts of sediments are resuspended. In the present paper the results obtained in three areas of the lagoon of Venice (Italy) are compared in order to quantify such effects and to highlight the different impacts occurring in the free clam-harvesting areas against the clam-farming ones. In field the sediment settlement rates were measured by means of sedimentation traps and the changes of bottom level were recorded by means of suitable devices fixed to the sediment surface. Results proved that clam-farming areas were affected by a minor sediment loss. In addition, marine seagrasses appeared to significantly favour the sedimentation and trapping of resuspended particles.
Keywords: Bivalves, Sedimentation, Erosion

Introduction
Tapes philippinarum (Adams & Reeve, 1950) was introduced in the lagoon of Venice in the early 1980s for economical proposes. In a few years' time it colonized large lagoon areas triggering an intense and indiscriminate harvesting activity. Until the late 1990s, harvesting areas, boat efforts and number of employees were not regulated, producing dramatic consequences for the environmental conditions. Since 2000 the local authorities have promulgated a plan for the management of clam resources in order to safeguard the ecosystem and to guarantee the maximum sustainable yield [1]. The main idea was to turn the free clam-harvesting into clam-farms, identifying suitable areas for this activity. The present paper aims at describing the effects of both free clam-harvesting and clam-farming activities on the sedimentation rates and bottom erosion.

Materials and Methods
Three areas were identified in the lagoon of Venice: one north of the Venice historical centre (northern area), the second in the central (central area) and the third in the southern (southern area) parts of the lagoon. The northern and central areas were still characterized by free clam-harvesting whereas the third was among the first licensed zones. Two sites were chosen in each area in order to have a harvesting/farming area and a control area. In each site a sedimentation trap, which collects settling sediments [2], and a device, to measure changes in bottom level [3], were placed. The sites were monitored monthly from February 2001 to January 2002.

Results and discussion
The results showed that the northern area (Fig. 1), with 268 kg dwt m^{-2} y^{-1} in the control site and 735 kg dwt m^{-2} y^{-1} in the harvesting site, was affected by a high sediment settlement so highlighting the strong impact of clam-catching. As in this part of the lagoon the water residence time is quite high, it can be considered that the resuspended sediments settled in almost the same zone where they were removed. On the other hand, the central area is characterized by a high water renewal, so the resuspended sediments are mainly lost seawards. In fact, in such area, the annual sedimentation (control: 119 kg dwt m^{-2} y^{-1}; harvesting site: 282 kg dwt m^{-2} y^{-1}) was, approximately, 2-3 times as low as in the northern one, although the harvesting pressure was even higher. In the site of the southern area, where clams are farmed, the sedimentation rates were not significantly different from the control one (control: 266 kg dwt m^{-2} y^{-1}; farming site: 257 kg dwt m^{-2} y^{-1}). In the farming area the low harvesting impact (1 harvest per m^{-2} in two years instead than 10-15 harvests per m^{-2} each year, as in the free clam-harvesting areas) and the role of seagrasses to avoid sediment loss were observed to be relevant. In fact, sedimentation rates were strongly different only in spring, because of seagrass unrooting inside the farming area, whereas in the other period sedimentation rates were similar (Fig. 1). In addition, the dense seagrass populations growing all around the farming area reduced the loss of fine sediments which were resuspended during the farming activities. Although the different sedimentation rates observed in the fishing and control areas, all the studied sites, on a yearly basis, showed an increase of the bottom level and hence a depositional trend; only few observations had negative values. Because a significant loss of fine material was recorded in other studies [1, 2, 3], these results probably depend on the fact that the selected stations were placed in areas low affected by the lagoon hydrodynamics or inside seagrass meadows. However, the results show that, in general, the sedimentations rates were significantly higher in the harvesting areas than in the control areas, whereas no significant differences between the clam-farming area and the control one were found. The planning of seeding and harvesting activities can be a really efficient tool to reduce the sediment resuspension. Moreover, the presence of seagrass meadows around the clam-farming areas can contrast the loss of fines reducing the environmental impact of such activities.

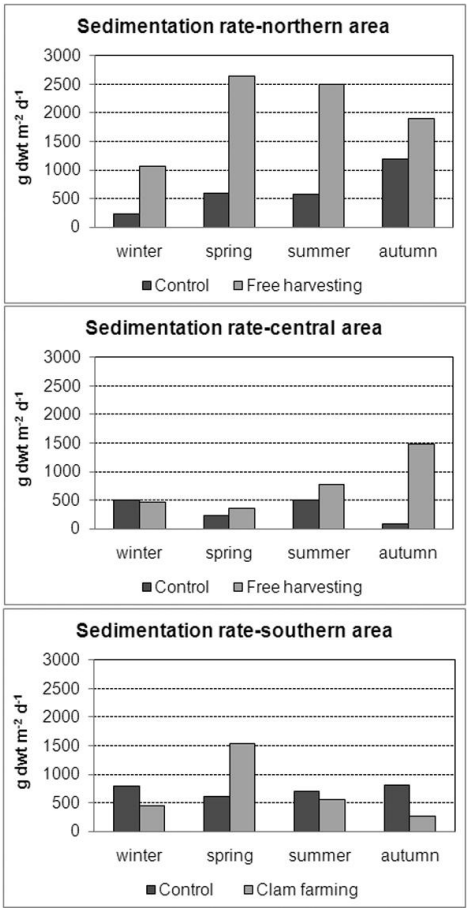


Fig. 1. Seasonal means of the sedimentation rates in the studied areas.

References
1 - Orel G., Boatto V., Sfriso A. and Pellizzato M., 2000. Fishing sources management plan for the lagoons of the Venice province (in Italian). Sannioprint. Provincia di Venezia eds. Venice, Italy, 102 pp.
2 - Sfriso A., Pavoni B., Marcomini A., Raccanelli S. and Orio A.A., 1992. Particulate matter deposition and nutrient fluxes onto the sediments of the Venice lagoon. *Environ. Technol.*, 13: 473-483.
3 - Sfriso A., Facca C. and Marcomini A., 2005. Sedimentation rates and erosion processes in the lagoon of Venice. *Environ. Int.*, 31: 983-992.

SEDIMENTOLOGICAL AND GEOCHEMICAL CHARACTERISTICS OF MODERN ARAGONITE-RICH SEDIMENTS IN MEDITERRANEAN KARSTIC MARINE LAKES (MLJET ISLAND, ADRIATIC SEA)

I. Sondi [1], N. Mikac [1], I. Jurina [1]*, N. Vdovic [1] and D. Barišic [1]
[1] Rudjer Boskovic Institute, Zagreb, 10000, Croatia - ijurina@irb.hr

Abstract
Sedimentological and geochemical characteristics of aragonite-rich sediments in semi-enclosed, karstic, marine lakes on the island of Mljet (Adriatic Sea), have been investigated. The lakes and their sediments are a unique sedimentological environment characterized by authigenic formation of aragonite mud in a restricted Mediterranean environment [1,2]. The results have shown that distribution, diagenesis, and the historical record of the presence of trace metals are mostly dependent on sedimentological processes associated with the inorganic formation of aragonite, and prevailing physico-chemical conditions.
Keywords: Geochemistry, Trace Elements, Adriatic Sea

Study Area
Veliko and Malo Jezero (the Mljet Lakes) are located in the western part of the island of Mljet (42º 47′ N, 17º 21′ E; Adriatic Sea) (Fig.1A). These are two typical semi-enclosed karst depressions (*doline* or sinkholes) which were formed under subaerial exposures, and are today submerged due to the Holocene sea-level rise [3]. Being connected with the sea, they contain sea water and therefore, can be termed marine lakes. Due to their depth of 47 and 29 meters, respectively, they can not be termed lagoons, because these are usually defined as shallow semi-enclosed water bodies having depths that seldom exceed a couple of meters.

Materials and Methods
Undisturbed sediment cores were collected at three sampling stations (Fig. 1A) by an Uwitec gravity corer, and immediately frozen and kept at -20ºC until further analyses were performed. Cores were cut into 2 cm segments and analyzed by X-ray diffraction, scanning electron microscopy, laser diffraction particle size analysis, high resolution inductively coupled plasma mass spectrometry, and gamma spectrometry.

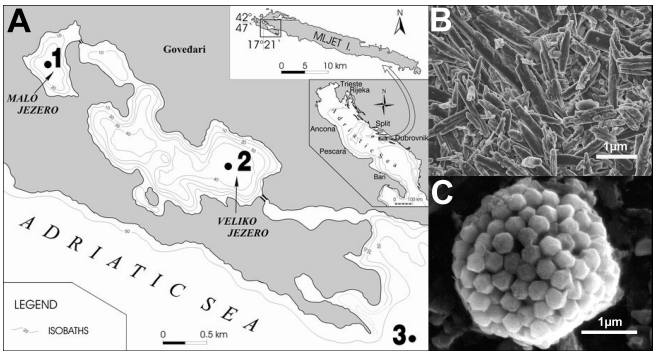


Fig. 1. The investigated area of the Mljet Lakes with: (A) sampling stations; (B), SEM microphotographs of needle-like aragonite particles; and (C) framboidal pyrite in sediments from Malo Jezero (Station 1).

Results and Discussion
The results have shown that sediment cores consist of muddy sediments which, according to Folk & Ward [4] can be classified as slightly gravely mud (Stations 1 and 2) and gravely mud (Station 2). There were no changes in the granulometric characteristics in core sediment samples with depth. Samples were mainly composed of aragonite, calcite, Mg-calcite, and dolomite. However, the ratio of carbonate polymorphs in surface sediments varied. Aragonite, in the form of needle-like particles (Fig. 1B), was the most abundant mineral phase in sediments at Station 1, with approximately 70% in total carbonate content. The vertical distribution patterns for redox sensitive trace elements, particularly Mo (Fig. 2), together with the presence, morphological characteristics and size of framboidal pyrite at the deeper part of core sediments (Fig. 1C), suggest the existence of euxinic conditions in the sedimentary system in lake history of the Malo Jezero (Station 1) [5]. Higher concentration of Cu, Cd, Zn, Sn, and Pb in surface sediments, taken from the sediment core from Station 2, indicates a substantial increase in their loads in the last 50 years. The only cause for this enrichment could be anthropogenic activities. However, the measured concentrations still reflect a relatively low level of anthropogenic metal pollution. The observed high concentration of Sr, and its distribution in sediments, is directly influenced by authigenic formation, deposition pattern and the content of aragonite. The obtained results should help to understand the processes involved in distribution of trace metals, governed and accompanied by early diagenetic processes and physico-chemical conditions, in aragonite-rich sediments in the Mediterranean marine environments.

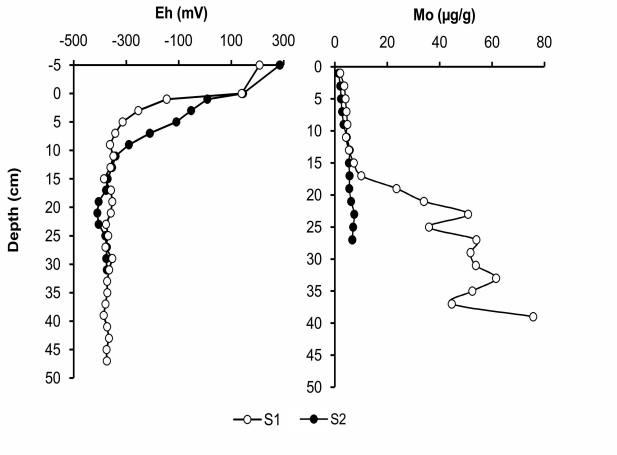


Fig. 2. Vertical distribution of redox potential (Eh) and concentration of Mo in the sediment cores from sampling Sations 1 and 2.

References
1 - Sondi, I. and Juracic, M., 2009. Whiting events and the formation of aragonite in Mediterranean karstic marine lakes: new evidence on its biologically induced inorganic origin. *Sedimentology*, doi:10.1111/j.1365-3091.2009.01090.x.
2 - Lojen, S., Sondi, I., Juracic, M., 2009. Geochemical conditions for the preservation of recent aragonite-rich sediments in Mediterranean karstic marine lakes (Mljet Island, Adriatic Sea, Croatia). *Mar. Freshw. Res.*, in press.
3 - Suric, M., Juracic, M., Horvatincic, N., and Krajcar Bronic, I., 2005. Late Pleistocene-Holocene sea-level changes and pattern of karstic coasts submersion-records from submerged speleothems along the Eastern Adriatic Coast (Croatia). *Mar. Geol.* 214, 163-175.
4 - Folk, R.L. and Ward, W.C., 1957. Brazos river bar: a study in the significance of grain size parameters. *J. Sediment. Petrol*. 27, 3-26.
5 - Wilkins, R.T., Barnes, H.L., and Brantley, S.L., 1996. The size and distribution of framboidal pyrite in modern sediments: an indicator of redox conditions. *Geochim. Cosmochim. Ac.*, 60: 3897-3912.

MUD VOLCANOES IN THE WEST ALBORAN BASIN: AGE VARIATION OF SOURCE SEDIMENTS, RECENT MUD VOLCANIC ACTIVITY, AND THEIR ROLE IN PALEOECOLOGY.

S. Spezzaferri [1], G. Gennari [1]*, A. Rüggeberg [2], C. F. López-Rodríguez [3], S. Margreth [1], M. C. Comas [3] and L. M. Pinheiro [4]
[1] University of Fribourg, Centre for Marine Studies, Dept. of Geosciences, 1700, Fribourg, Switzerland - giordana.gennari@unifr.ch
[2] Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR), Wischhofstasse 1-3, D-24148 Kiel, Germany (Present address: Renard Centre of Marine Geology, Ghent University, Krijgslaan 281, S8, B-9000 Gent, Belgium).
[3] Instituto Andaluz de Ciencias de la Terra (C.S.I.C. University of Granada), Campus Fuentenueva sln, 18002 Granada, Spain.
[4] Departamento de Geociências and CESAM, Universidade de Aveiro, 3810-193 Aveiro, Portugal.

Abstract
Our micropaleontological investigation on the mud breccia matrix from three mud volcanoes in the Alboran Sea (Western Mediterranean) reveals that the extruded sediments are from olistoliths of different ages contained in the main olistostromic complex. The ages of their more recent activity has been dated with AMS ^{14}C. The mud breccia acts as an ideal substratum for cold-water coral colonies, whose development is, however, not linked to seepage activities.
Keywords: Alboran Sea, Mud Volcanoes, Foraminifera

The Dhaka, Maya and Carmen mud volcanoes (MV), located in the Mud Diapir Province in the Western Alboran Basin along the Moroccan Coasts were cored during the TTR-17 Leg 1 research cruise. Cores were taken on the top of mud volcanoes at Dhaka (water depth of 370 m) and Maya (water depth of 410 m) and on the flank at Carmen MV (water depth of 806 m).
Recent volcanic activities have been dated by mean of AMS ^{14}C. At Maya MV the most recent activity is as old as 15583 +/- 185 yrs BP. At Dhaka MV the most recent volcanic activity occurred between 4346 +/- 60 yrs BP and 4165+/- 62 yrs BP.

Mud diapirism and mud volcanism in the area are supposed to originate in the lowermost sedimentary sequence on the basis of both seismic interpretation [1] and micropaleontological analysis of the extruded mud breccias [2]. A new micropaleontological study was undertaken to better constrain the age of the source sediments.
At Dhaka MV the planktonic foraminiferal assemblages present in the mud breccia matrix result to be mostly composed by rare Recent-Holocene forms and more abundant mixed Late Cretaceous (Lower and Late Maastrichtian), Miocene (generally Serravallian) and Pliocene species. Late Eocene and Oligocene specimens, together with very rare shallow water benthic forms such as *Amphistegina* sp. and *Elphidium* spp. are also documented.
At Maya MV planktonic foraminifera of Late Cretaceous (Campanian - Maastrichian) are dominant, while Miocene and Oligocene forms are very rare. Shallow water specimens of *Elphidium* are present but generally rare.
At Carmen MV the mud breccia contains dominant planktonic foraminifera from Zones N8-N10 (Middle Miocene). Late Cretaceous species are very rare and only very rare specimens of Upper Albian species have been observed. Shallow water species include *Ammonia beccarii* and *Elphidium* spp.

Based on these observations we identify the lowermost olistostromic sedimentary unit present in the Alboran Sea and documented in [1] as the main source of the extruded material at Dhaka, Maya and Carmen Mud Volcanoes [2]. We also suggest that the age difference in the source sediments of the three mud volcanoes is due to the presence of olistoliths of different ages in the main olistostromic complex.
On top of the mud breccia extruded by both Dhaka and Maya MVs small patch reef and/or isolated cold-water corals found an ideal substratum for colonization. However, no relation with seepage is observed at both mud volcanoes as indicated by carbon isotopes values of benthic foraminifera in the range of "normal" marine waters not affected by hydrocarbon.

This study is funded by the Swiss National Science Foundation Projects 200021-111694 and 200020-117928.

References

1 - Jurado M.J. and Comas M.C., 1992. Well log interpretation and seismic character of the Cenozoic sequence in the Northern Alboran Sea. *Geo-Mar. Lett.*, 12: 129-136.
2 - Sautkin A., Talukder A.R., Comas M.C., Soto J.I., Alekseev A., 2003. Mud volcanoes in the Alboran Sea: evidence from micropaleontological and geophysical data. *Mar. Geol.*, 195: 237-261.

GAS BUBBLING AND ROCKS FORMATION IN THE ADRIATIC SEA

Antonio Stefanon [1]* and Antonio Campagnol [2]
[1] Ca'Foscari University of Venice Dept of Environmental Science, 30123, Venezia, Italy - stefanon@unive.it
[2] Antonio Campagnol Capitaneria di Porto. Fondamenta delle Zattere, 30100, Venezia, Italy

Abstract

Gas seeps and related rocks are known both in the northern and central Adriatic sea. Gas imageries – "ghosts" included – in boomer records appear to be limited north of the Jabuca deep only but are very frequent north of the Po delta. The rocky outcrops in the northern Adriatic – locally named "tegnue" by fishermen – are made up by organic reefs grown upon base rocks (methanites) formed by the cementation of local sediments because of methane seeps. The timing of these processes is certainly related to the sea level and climatic changes and will be properly defined, as hereby outlined

Keywords: Shoreline Evolution, Sediments

The rocky outcrops off the Italian coasts both in the northern and central Adriatic are related to gas seeps, but the ones in the northern part lie at limited depth (less than 50 meters) and host abundant organic growth capable of forming luxurious algal reefs [1]. The others, in the central Adriatic, are relevant to the pock marks area in about a 100 meters water depth, east off Ancona. They are located over a large oil/gas field [2], and the dredged rock samples appear free of organic growth. The area is poorly studied and the situation appears to be very similar to the much better known North Sea pock marks. The Northern Adriatic Sea rock outcrops are formed by hard substrata supporting the growth of algal reefs [3], locally named "tegnue" by fishermen. These base rocks are locally sea bed sediments lithified by methane seeping through them [4]. Depending upon the sediments permeability (both horizontal and vertical), the seeping methane forms horizontal slabs, sometimes superimposed and cemented to one another, or vertical pinnacles less than 2 meters high. Since all these rocks must have been cemented only under a sediment cover, their outcropping must be due to a strong erosion, responsible of wiping out at least 7 metres of loose sediments, as one of the rocks is about 6 meters high [5]. The ages of the algal reefs (not yet properly determined) which now live at depths from about 8 to 45 metres are strictly depending on the time the base rocks were uncovered and/or submerged during the last deglaciation. Other questions are the age of the bed rocks found at different depths: the ages of their datable carbonates might have been corrupted by the age of the methane involved in their cementation New outcrops of base rock have been found last year off Grado, in about 2.5 metres water depth only, close to the remains of a ancient church, submerged now at 3.5 metres water depth. And yet archive documents testify that church hosted a holy service in 1723 ! These unexpected findings suggest further new ideas on the Northern Adriatic Sea evolution since at least the last glaciation.

References

1 - Stefanon, A., 2007.Methane-Induced Rocks Outcropping In The Northern Adriatic Sea: New Hints. Atti "China–Italy Bilateral Symposium on the Coastal Zone: Evolution and Safeguard." Editors F. Marabini, A. Galvani, M. Ciabatti. Bologna. 131-136.

2 - Stefanon, A., 1981. Pockmarks in the Adriatic Sea? IAS 2nd Eur. Mtg., Bologna, 189-192.

3 - Casellato, S. Stefanon, A. 2008: Coralligenous habitat in the northern Adriatic sea: an overview. *Marine Ecology*. ISSN 0173-9565

4 - Stefanon A., Zuppi G.M., 2000. Recent Rock Formation in the Northern Adriatic Sea: Hydrogeological and Geotechnical Implications. *Hydrogeology* n°4, pp. 3-10.

5 - Stefanon, A., 1984. Sedimentologia del Mare Adriatico: rapporti tra erosione e sedimentazione recente. Boll. *Oceanol. Teor. Appl*., II, 4, 281-324.

GAS DETECTION CAPABILITIES, GAS INDUCED ACOUSTIC STRUCTURES AND GHOST IMAGERIES IN UNIBOOM RECORDS IN THE ADRIATIC SEA

Antonio Stefanon [1]* and Andrea Falconi [2]
[1] Ca'Foscari University of Venice Dept of Environmental Science, 30123, Venezia, Italy - stefanon@unive.it
[2] CAM IDROGRAFICA, 30126, Venezia, Italy

Abstract
UNIBOOM and similar boomer systems can easily monitor the presence of even the slightest gas content in the sediments, because of the relevant variations in the sound velocity and in the acoustic impedance The gas behaviour related to the grain size and the permeability versus the frequency and the signature of the acoustic impulse give sometimes inexplicable or at least very difficult imageries and records.
Keywords: Stratification, Sediments, Geophysics, Acoustics

For a proper appreciation of the importance of gas in the acoustic behaviour of wet sedimentary sequences we must take into account the strong variations in the sound speed in the different systems, according to the gas percentage in the interstitial waters. The relevant sound velocity in waters can vary from about 1500 m/s down to about the same speed in air, that is in the order of 350 m/s! This implies large variations of the acoustic impedance and very strong gradients in limited space, depending from the gas content only. The history of sedimentary sequences may be better described [1] if different gas diffusion and/or intrusion can be attributed to episodes of the same type but occurring in different times. A good example is offered by the sedimentary sequence of the Jabuka deep [2] in the central Adriatic, where surface pockmarks and buried ones (aborted?) appear to have occurred in different times, but driven by the same and much more deeper gas source. Gas concentrations in sedimentary layers give more problems than help in evaluating the acoustic records given by UNIBOOM, boomers or similar high resolution microseismic systems. In any case the presence of gas always reduces more or less the acoustic penetration. Vertical penetration of 100 metres or more can be easily achieved, in fine, no-gassy sediments as in the southern part of the central Adriatic sea, where a resolution of about 20 centimetres can be achieved. Penetration over 200 metres is rather unusual and achievable only in areas free from potential gas sources as in the gulf of Taranto, in the Jonian see. Some other examples are given, as also "ghost" imageries and geologic hazards [3]. The excellent results can be achieved only if the behaviour of the used system is very well "understood" by the user, with special regard to the geometry of the towed gears. Most of the "tricks" used to achieve the best results lie in regulating the distances and the reciprocal position of the hydrophone and the boomer plate, respectively emitting and receiving the signals. If the geometry is perfectlyset, the acoustic multiples will disappear and there will be no need at all to filter the received echoes. In some cases the geometry must be adjusted to the acoustic characteristics of the boat or ship used. Such difficulties are generally underestimated by the "standard" users, who are not always satisfied with their results. The conclusion is that in the last ten to twenty years the use of UNIBOOM and similar sound systems has largely diminished in favour of systems that are much more simple and easier to handle, like sub-bottom profilers, CHIRP and similar ones

References
1 - STEFANON, A., 1980. The acoustic response of some gas-charged sediments in the Northern Adriatic sea. Bottom Interacting Ocean Acoustics Conference, SACLANT ASW Centre, La Spezia, 73-84.
2 - STEFANON, A.; 1981: Pockmarks in the Adriatic Sea? IAS 2nd Eur. Mtg., Bologna, 189-192.
3 - STEFANON, A., 1985. Marine sedimentology through modem acoustical methods: UNIBOOM. *BolI. Oceanol. Teor. Appi*., III, 2, 113-144.

PATELLA RUSTICA FROM OFFSHORE SHELL ASSEMBLAGES IN THE CENTRAL ADRIATIC RECORDS HUMAN USE OF LIMPETS IN MEDIEVAL TIMES

Marco Taviani [1], Lorenzo Angeletti [1] and Alessandro Ceregato [1]*
[1] ISMAR - CNR, Via Gobetti 101, I-40129 Bologna, Italy - alessandro.ceregato@bo.ismar.cnr.it

Abstract
Empty shells of the upper intertidal limpet *Patella rustica* were recovered in the central Adriatic at a depth of c. 200 m. These shells dated at 1050 ± 97 yrs BP cal. were likely discarded by medieval seafarers, probably using limpets as food or fish baits.
Keywords: Adriatic Sea, Gastropods, Fisheries

Introduction
Offshore sampling of death shell assemblages in the central Adriatic during CNR cruise ARCO of RV *Urania* recovered empty shells belonging to *Patella rustica* Linnaeus, 1758 (Fig. 1) at an average depth of c. 200 m. This common upper intertidal limpet inhabits rocky substrate in the Mediterranean Sea and Eastern Atlantic Ocean (e.g. [1]).

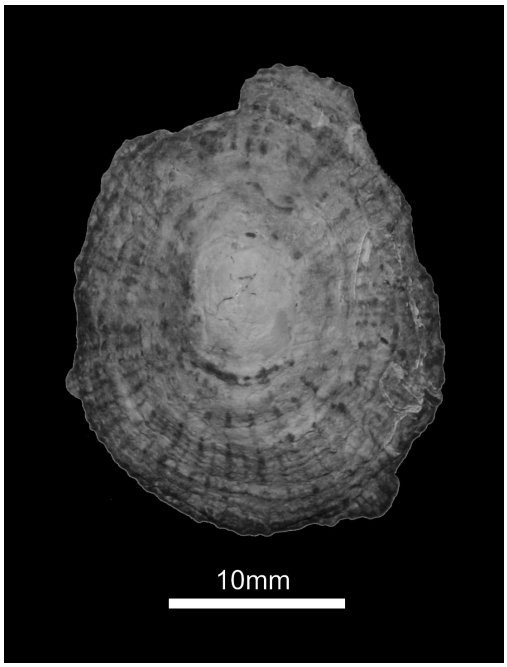


Fig. 1. *Patella rustica* Linnaeus, 1758. - St. ARCO 40

Two adult shells were identified at stations ARCO 40 and 50 (tab.1) characterized by an abundance of deep water corals (*Lophelia pertusa*, *Madrepora oculata* and *Dendrophyllia cornigera*)dated at the latest Holocene, and last glacial molluscs (predominantly the subtidal bivalves *Pseudamussium peslutrae* and *Panomya norvegica*). Since *Patella rustica* is ecologically inconsistent with both assemblages, the reason of its occurrence in such deposits was inquired.

Tab. 1. Two adult shells were identified at stations ARCO 40 and 50

Station	Gear	Lat Start N	Long Start E	Lat End N	Long End E	Depth m (Start/End)
ARCO 40	Epibenthic dredge	42°52.90'	15°03.67'	42°55.24'	15°02.33'	187/190
ARCO 50	Epibenthic dredge	43°10.86'	15°09.86'	43°10.80'	15°08.10'	210/232

Discussion and results
One shell (ARCO st. 50) was AMS-14C dated providing a calibrated age of 1050 ± 97 yrs BP. The presence of limpets of such an age in these offshore deposits may be accounted by (i) natural transport from a nearby insular rocky shore, (ii) dropping from birds (for example a seagull), or (iii) by human interference. The absence of suitable rocky substrates in this area permits to discard the first option; bird discard so far from the nearest coastline is a remote possibility. Therefore, in all likelihood, these medieval limpets were deliberately discarded by humans, possibly Adriatic seafarers. In general limpets were and are collected either for human consumption or as baits for fishing (e.g., [2; 3]). We cannot identify at present neither who were the users of limpets nor the limpets' actual utilization. As a working hypothesis we suggest that seafarers possibly came from Dalmatian coasts characterized by abundant and accessible limpet populations because of the widespread of suitable rocky shores.

Acknowledgments : Thanks are due to Captain , cruise and colleagues onboard RV *Urania* during cruise ARCO (December 2008). Partial funding provided by CNR and EU Hermione project.

References
1 - Lima F.P., Queiroz N., Ribeiro P.A., Hawkins S.J., Santos A.M., 2006. Recent changes in the distributions of a marine gastropod *Patella rustica* Linnaeus, 1758, and their relationship to unusual climate events. *J. Biogeogr.*, 33:812-822.
2 - Cabral J.P., da Silva A.C.F., 2003. Morphometric analysis of limpets from an Iron age shell ridde found in northwest Portugal. *J. Archaeol Sci.*, 30: 817-829.
3 - Milner N., Barrett J.J., Welsh J., 2007. Marine Resource intensification in Viking Age Europe: the molluscan evidence from Quoygrew, Orkney. *J. Archaeol Sci*., 34: 1461-1472.

GEOLOGICAL RISK AND CLIMATIC CHANGES ON THE IONIAN CALABRIAN COASTAL ENVIRONMENT: A CASE STUDY

Chiara Tessarolo [1]* and Alessandra Savini [1]

[1] Dip. Scienze geologiche e geotecnologie, Università Milano Bicocca, Milan, 20126, Italy - chiara.tessarolo@gmail.com

Abstract

The recent origin and the active dynamism of the Italian margins, associated to the sea level variations and the climate, represent an important aspect connected to the actual coastal environment. Recent Morpho-Bathimetric survey allows to map a wide area of the Calabrian margin, pointing out interesting features and characteristics suitable for the geomorphology and the possible coast modification comprehension.

Keywords: Coastal Systems, Swath Mapping, Active Margins

The tectonic evolution of the italian region, connected to the climate impact and to the sea level oscillation [1], make the coastal domain a very variable and interesting zone to study and comprehend.

Going beyond this environmental point of view, the strong colonization of the coasts in the past decades has strongly impacted its actual conformation, pushing both the research and politic interests to a deeper consideration of this zone [2].

One of the main aim of these studies is based on the comprehension and evaluation of the coastal zone evolution, in function of climate changes and of the directly connected suitables risks [3]. From this point of view, the Geologic Sciences and Geotechnologies Depatment of the Milano Bicocca University has been recently involved in the study of a sector of the Ionian Calabrian Margin, first with the VECTOR Project (Vulnerability of the italian coastal area and marine Echosystems to Climatic changes and Their rOle in the mediteRranean carbon cyrcles), and more recently by the MAGIC Project (Marine Geohazards Along the Italian Coast).

These two projects lead to the realization of an high detail Morpho-Bathymetric data mapping on a wide sector of the Calabrian seafloor, realized using a Multibeam Echosounder System (Reson Seabat 8160).



Fig. 1. Location and detail of the realized swath survey on the Ionian calabrian Margin (Magic-Vector Projects)

The data processing and elaboration allow to investigate the shelf and slope domains, recognizing interesting features developed at different scale (Canyons, incisions, slope and slide scars and deposits,.. [4]), and to advance preliminary hypothesis about the local margin evolution.

The actual configuration of this margin is in fact the result of the traslation of the calabrian Arc linked to the Tyrrhenian basin opening (Miocene), and of the coupled occurrence of compressive stress on the Eastern advancing front, cause of the local high relief, of the narrow shelf, and of the still active tectonic [5], with an evaluated uplift trend of 0.89 – 1.4mm/y [6].

These elements, coupled to climate regime, contribute to the occurrence of mass wasting episodes on the shelf and upper slope, increasing the local instability of the whole submerged margin, and stressing the possibility of risks, for the human infrastructures and cities wide extended on the coastal zone, whose comprehension is the main aim of the indicated studies.

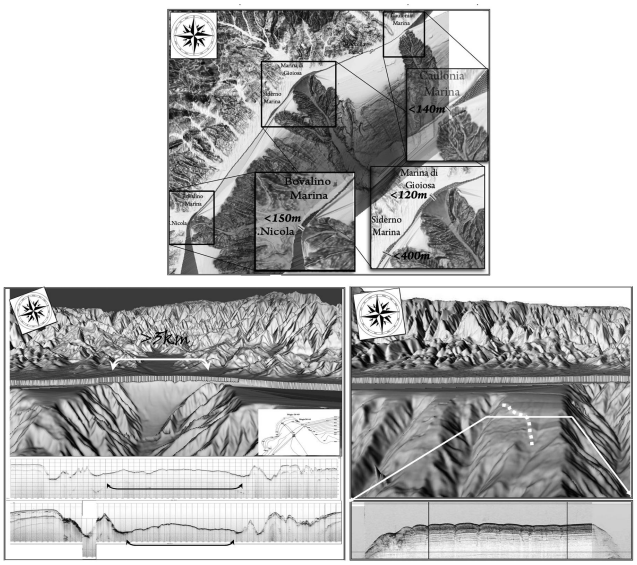


Fig. 2. Risk elements on the considered margins: the canyons head, deep incided on the shelf and very close to the coastal line, and the seismo-stratigraphic evidence of creep like, instable features, observed on channel rim.

References

1 - F. Antonioli et al.2006. Elevation of the last interglacial highstand in Sicily (Italy): A beachmark of coastal tectonics, Quat. Int. 145–146 , pp. 3–18.

2 - F. ZOLEZZI, C. M. TRAVERSO, E. C J. PARKER. 2009.Offshore Geohazards and their Implication to Industry. Rend. online Soc. Geol. It., 7.

3 - F.L. Chiocci et al Ed. 2009. Rendiconti Online Società Geologica Italiana – Volume 7 Extended abstract – International Conference on Seafloor mapping for Geohazard Assessment.

4 - C. Tessarolo, E. Malinverno, M. Agate, G. Di Grigoli and C. Corselli. June 2008. Preliminary data concerning the morphology of a Calabrian Ionian margin area: Caulonia and Marina di Gioiosa canyons. Chemistry and Ecology Vol. 24, No. S1, , 225–242.

5 - Jenny, S. et al., 2006. Seismic potential of Southern Italy. *Tectonophysics*, 415,81-101.

6 - R.Westaway, 1993. Quaternary uplift of southern Italy, J. Geophys. Res. B 98 pp. 21741–21772.

SOUTH WEST ADRIATIC MARGIN MORPHOLOGY AND DEEP-SEA MACROBENTHIC ECOSYSTEMS

F. Trincardi [1], L. Angeletti [1], A. Asioli [2], E. Campiani [1], A. Ceregato [1], F. Foglini [1]*, A. Freiwald [3], A. Remia [1], M. Taviani [1] and A. Vertino [1]

[1] CNR Ismar Bologna, 40129, Italy - federica.foglini@bo.ismar.cnr.it

[2] Istituto di Geoscienze e Georisorse, IGG-CNR, 35100, Padova, Italy

[3] GeoZentrum Nordbayern, Universität Erlangen-Nürnberg, 91054, Erlangen, Germany

Abstract

The integration between high-resolution multi beam bathymetry, side scan sonar data, high resolution chirp sonar provide a frame functional to the identification and mapping of a variety of deep-sea benthic habitats including healthy Lophelia, Madrepora, Dendrophyllia and Desmophyllum often associated with sponges and polychaetes. Coral growth took place in areas of irregular topography, created by large slide blocks such as Gondola slide, or on the steep flanks of Bari canyon and Dauno seamount. In both cases a key factor is the concurring action of dense NAdDW water mass impacting seasonally the SW Adriatic margin.

Keywords: Continental Slope, Currents, Swath Mapping, Deep Sea Ecology

The SW Adriatic Margin stretches NW-SE for about 150km and it is affected by numerous failure events that generated slide scars up to 10 km wide and extensive slide deposits with run out distances greater than 50 km from the shelf edge to the slope base (Gondola slide). On the open slope, the interaction between cascading and contour-parallel bottom currents with the irregular morphology of the margin leads to the definition of locally enhanced energetic condition at the sea-floor, as suggested by a suite of intermingled bottom current deposits and related erosional features (sediment drifts, bifurcated sediment waves, furrows and scours) ([3]). Bari Canyon is the main sediment conduit deeply entrenched in the SW-Adriatic Margin formed approximately 400ky ago through mass failures and turbidity-current down cut during successive glacial sea-level low stands (Fig. 1).

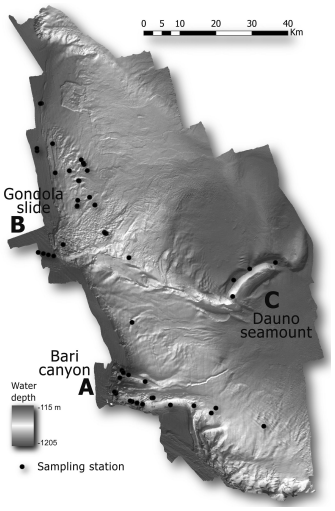


Fig. 1. High Resolution Multi Beam Bathymetry of the SW Adriatic Margin (Grid size 20m).

The integration between high-resolution multi beam bathymetry, side scan sonar data, high resolution chirp sonar provide a detailed morphological reconstruction of the entire margin and the characterization of the main geological features and sedimentological processes. Furthermore, it provided a frame functional to the identification and mapping of a variety of deep-sea benthic habitats ([2]). Under this respect noteworthy is the discovery along the SW Adriatic margin of a number of deep-water coral occurrences including healthy *Lophelia*, *Madrepora*, *Dendrophyllia* and *Desmophyllum* often associated with sponges and polychaetes ([1]). Coral growth took advantage of the irregular topography with positive relief created by large mass wasting deposits, such as Gondola slide and the concurring action of dense NAdDW water mass on the irregularly shaped SW Adriatic margin (Fig. 2).

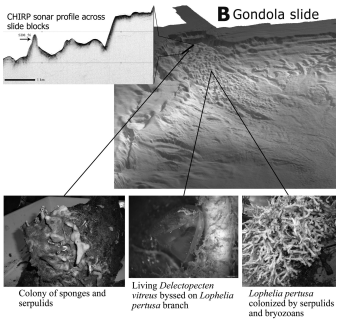


Fig. 2. Multi beam Bathymetry of the Gondola slides integrated with chirp profile and coral occurrences. Coral growth took advantage of the irregular topography with positive relief created by large mass wasting deposits

References

1 - Freiwald A, Beuck L., Rueggeberg A., Taviani M.,Hebbeln D. and R/V Meteor M70-1 Participants. *Oceanography* 22(1)

2 - Trincardi, F., Foglini, F., Verdicchio, G., Asioli, A., Correggiari A., Minisini, D., Piva, A., Remia, A., Ridente, D., Taviani, M. 2007. The impact of cascading currents on the Bari Canyon System, SW-Adriatic Margin (Central Mediterranean). *Marine Geology, Volume 246, Issues 2-4, pp 208-230*

3 - Verdicchio, G., Trincardi, F., 2006. Short-distance variability inabyssal bed-forms along the Southwestern Adriatic Margin (Central Mediterranean). *Marine Geology*, 234, 271–292.

THE IMPACT OF DENSE SHELF WATER CASCADES ON THE SEAFLOOR OF THE SW ADRIATIC SLOPE

Fabio Trincardi [1] and Frederica Foglini Foglini [1]*
[1] CNR Ismar Bologna, 40129, Italy - federica.foglini@bo.ismar.cnr.it

Abstract
Cascading North Adriatic Dense Water (NAdDW) impact energetically the seafloor of the SW Adriatic margin, eroding and depositing large amounts of fine-grained sediment below a markedly erosional upper slope. This cascading NAdDW is generated in the broad and shallow North Adriatic shelf through intense winter cooling and evaporation. The NAdDW flows, southward along the Italian coast, reaches the shelf break, typically over a prolonged interval (several weeks) at the end of the winter season, and sinks across the slope By cascading across the slope, the dense NAdDW impinges the seafloor and interacts with the complex margin morphology, generating: 1) patchy fields of large-scale mud waves, 2) a variety of erosional bed forms, such as moats, furrows and comet marks, 3) an area of widwspread sea floor erosion.
Keywords: Currents, Deep Sea Sediments, Adriatic Sea, Swath Mapping

The North Adriatic Dense Water (NAdDW), represents the densest water of the whole Mediterranean and generates in the broad and shallow North Adriatic shelf through intense cooling and evaporation. The NAdDW forms during the winter months, flows southward along the Italian coast and cascades off the shelf break, over a prolonged interval (typically several weeks) at the end of the winter season. The South Adriatic basin is also intruded by the LIW (Levantine Intermediate Water), a salty water mass that enters the south Adriatic through the Otranto Strait and flows southward along the western Adriatic, along the upper slope ([2]). The NAdDW is active every year for a short interval can exceed speeds of 60cm/s ([4]), depending on the meteorological conditions for each year, and may or may not reach a density capable to allow sinking all the way to the basin floor (in 1200m); the LIW, less energetic, impacts the sea floor only at depths less than 600m. By cascading across the slope, the dense water impinges the seafloor and interacts with the complex margin morphology, caused by the presence of active faults and exposed slide scars and a variety of mass-transport deposits, generating patchy fields of large upslope-migrating mud waves that are spatially associated with moats, furrows and comet marks ([3], [4]) (Fig. 1)

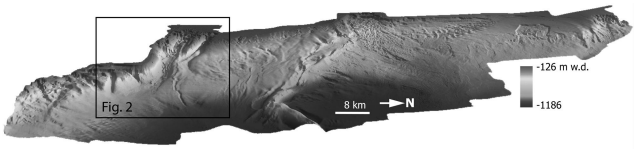


Fig. 1. 3D image of the Multi Beam Bathymetry of the SW Adriatic Margin

Sediment cores and seismic correlations suggest that all these bed forms, both erosional and depositional, are primarily active during the modern interglacial as well as during the last interglacial, when climatic forcing also allowed the formation of the NAdDW on the shallow north Adriatic shelf ([5]). The spatial distribution and inferred genetic association of erosional and depositional bedforms on the SW Adriatic slope define two preferred paths along which the NAdDW cascade into deeper waters before exiting the Adriatic through the Otranto Strait. Both pathways: 1) represent the time-averaged response of repeated dense-water cascading; 2) extend to the bottom of the basin (1200 m); 3) define a few-km-wide "core" and a "fringe" area where mudwaves develop and show increasing continuity away from the "core" (Fig. 2).

More in general, the sedimentological study of the modern sea floor in relation to near-seafloor oceanographic processes, inevitably relies on implicit assumptions on the equilibrium between the sea floor (and its erosional and/or depositional bedforms) and processes that can only be observed (and measured) over a time span of few months to few decades, at the most ([1]). A major theoretical and practical question is therefore establishing whether the modern sea floor "landscape" is the product of 1) extreme events, 2) rather uniform events that repeat themselves with some sort of regularity or 3) a combination of both.

By reviewing the main morphological and stratigraphic products of the dense-water cascading process in this area, this contribution aims at addressing the following, more general questions: 1. Do oceanographic processes on the shelf lead to focussing of cascading processes along preferred slope pathways 2. How does the interannual variability in production of dense water, affect the location where cascading is initiated, the duration of the process (few days to several weeks) and its capability to reach the bottom of the basin (1200m) 3. During its downslope flow, does the NAdDW spread laterally, entraining ambient water, or remains focussed along a narrow belt In this context, what dynamic interaction occurs between the NAdDW and the slope parallel (salty) LIW 4.The upslope-migrating mud waves have furrowed seaward limbs indicating that they undergo erosion. Is this an indicator of an ongoing intensification of the bottom current regime or, rather, of a reduction of sediment supply.

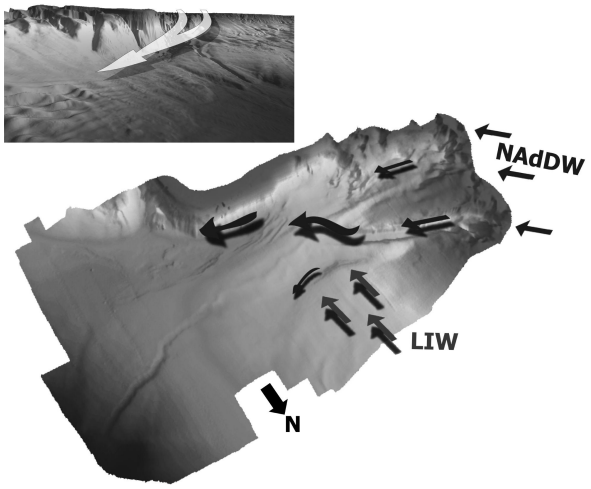


Fig. 2. 3D image of theBari Canyon System (BCS) representing the major sediment conduit on the SW Adriatic margin. The figure shows two preferred paths along which the NAdDW cascade into deeper waters before exiting the Adriatic through the Otranto Strait.

References

1 - Canals M., Danovaro R., Heussner S., Lykousis V., Puig P., Trincardi F., Calafat A. M., Durrieu De Madron X. and Palanques A., 2009 - Cascades in Mediterranean Submarine Grand Canyons. *Oceanography*, 22, pp: 32-49, Oceanography 22(1).

2 - Cushman-Roisin B., Gacic M., Poulain P.M., Artegiani A., (Eds.) 2001 - Physical oceanography of the Adriatic Sea Past, present and future. 304 pp., *Kluwer Academic Publisher*, London.

3 - Turchetto M., Boldrin A., Langone L., Miserocchi S., Tesi T., Foglini F., 2007 - Water dynamics and sediment transport associated with the Bari canyon in the southern Adriatic Sea. *Marine Geology*, Vol. 246: pp. 231-247.

4 - Verdicchio G. & Trincardi F., 2006 - Short-distance variability in slope bed-forms along the Southwestern Adriatic Margin (Central Mediterranean). *Marine Geology* (Weaver P., Canals M., e Trincardi F. Eds.), Vol. 234, pp. 271–292.

5 - Verdicchio G., Trincardi F., Asioli A., 2007 - Mediterranean bottom current deposits: an example from the Southwestern Adriatic Margin. *Geological Society of London*, Special Publication, Vol. 276: pp. 199–224.

RADIO ISOTOPES AS TRACERS FOR THE STUDY OF THE SUBMARINE GROUNDWATER DISCHARGE OF KALOGRIA BAY, SW PELOPONNISSOS, GREECE

C. Tsabaris [1]*, D. Patiris [1], K. Ioannides [2], A. P. Karageorgis [1], K. Stamoulis [3], G. Eleftheriou [4], D. Georgopoulos [1] and E. Papathanassiou [1]

[1] Hellenic Centre for Marine Research, Institute of Oceanography, 19013, Anavyssos, Greece - tsabaris@ath.hcmr.gr

[2] University of Ioannina, Nuclear Physics Laboratory

[3] University of Ioannina, Archaeometry Center

[4] National Technical University of Athens, Department of Applied Mathematic and Physical Science

Abstract

A preliminary study has been performed estimating the residence time of a submarine groundwater discharge in Kalogria Bay (SW Peloponnissos, Greece). A number of naturally occurring radio-nuclides (^{222}Rn, ^{214}Pb, ^{214}Bi, ^{228}Ac, ^{208}Tl, ^{40}K) have been used as tracers measuring samples of sea, rain and groundwater by means of LSC and HpGe. Radon daughters measurements were also performed using the *in situ* underwater autonomous gamma-ray detection system "KATERINA". The estimation of the residence time of groundwater has been attempted using a different approach to standard methods, based on activity ratio concentrations of radium daughters

Keywords: Radionuclides, Instruments And Techniques, Monitoring, Brackish Water, Aegean Sea

Introduction

During the last decades, submarine groundwater discharge (SGD) has been recognized as an important hydrological mechanism affecting numerous phenomena (e.g. elements cycles, contamination by heavy metals and radionuclides, eutrophication) relating to the coastal zone. The main methods for detection and quantification of SGD are based on: a) direct physical measurements with e.g. seepage flux meters; and b) tracer techniques, estimating the concentrations of geochemical substances which are naturally enriched in groundwater paths. Amongst the tracer techniques, those based on radioactive isotopes as radium, radon and their daughters were used in several studies to investigate the temporal and spatial distribution of SGD [1, 2], the coastal mixing rates [3] and the residence time of groundwater through the aquifer paths [4]. In this work, a radiological study is presented involving numerous radiotracers (^{40}K, ^{222}Rn, ^{214}Pb, ^{214}Bi, ^{226}Ra, ^{228}Ac, ^{208}Tl, ^{3}H) for the estimation of groundwater residence time of the SGD point source located in Kalogria Bay (SW Peloponnissos) .

The study area, materials and methods

The Kalogria Bay is located in southwestern Peloponnissos, in the Messinia prefecture. Many locations of submarine groundwater discharges are easily visible around the bay, although the main SGD point source is located ~180 m offshore. At this location, groundwater is emanating into the sea mainly through a small submarine cave at 25 m depth. The site is reached by small boats and divers are occupied to collect water samples and to deploy inside the cave a small lander equipped with several sensors. *In situ* measurements are performed by "KATERINA", an autonomous underwater gamma-ray NaI (Tl) detector [5, 6], monitoring the radioactivity concentration of radon daughters (^{214}Pb, ^{214}Bi), ^{228}Ac, ^{208}Tl and ^{40}K. Also, for subsequent measurements in laboratory, a quantity of 10 mL from the water samples is immediately added by syringe inside plastic vials containing 10 mL of scintillation cocktail. The vials are transported to the laboratory within the first 24 hours after sampling, for gross alpha and beta counting of radon and its daughters by a Liquid Scintillation Counter (LSC) TriCarb 3170 TR/LS. Furthermore, 0.6 L of water samples are measured in the laboratory by means of a High Purity Germanium detector (HpGe) for any gamma-ray emmiter. In addition, after a simple distillation procedure 8 mL of groundwater, water from terrestrial springs, and rain are added in glass vials containing 12 mL of scintillation cocktail for tritium (^{3}H) concentration measurements by LSC method.

Results and Discussion

I*n situ* gamma-ray spectra from "KATERINA" detector exhibits radon daughters contributions since gamma-ray emitters at 351 keV (^{214}Pb), 609 keV (^{214}Bi) are clearly observed. Measured ^{214}Pb and ^{214}Bi activities are 550 ± 45 Bq/m^3 and 575 ± 45 Bq/m^3, respectively. The activity of ^{40}K is 11300 ± 95 Bq/m^3 while ^{228}Ac and ^{208}Tl exhibit activities of 130 ± 11 Bq/m^3 and 160 ± 15 Bq/m^3 respectively. Radon activity concentration by the LSC method during the same period (July 2009) exhibited values varying from 1200 ± 100 to 800 ± 100 Bq/m^3. Regarding ^{3}H concentration, the estimated values varied between 4.3 ± 1.7 to 5.9 ± 1.7 TU. These measurements have to be combined with ^{3}H measurements of rainwater collected from the same region in order to achieve an ageing of the water. Also, a method for the residence time estimation of groundwater was applied, as proposed in the literature [4]. This model assumes the investigating system is in steady-state which means that radium isotopes additions (radium flux from groundwater) are balanced with losses (mixing and radioactive decay). The activity ratio of ^{224}Ra/^{228}Ra has been substituted by ^{208}Tl/^{228}Ac as ^{228}Ra and ^{228}Ac reach a secular radioactive equilibrium after 1.5 days while the activity ratio of ^{224}Ra to ^{208}Tl remains constant ($\approx$ 2.6) after 2 days. By means of a HpGe detector, radium daughter isotopes ^{208}Tl (^{224}Ra) and ^{228}Ac (^{228}Ra) concentration activity ratios was calculated into the groundwater path (outlet region), as well as in the inventory where the groundwater discharges. The residence time using the aforementioned model was calculated at 2.5 ±1.3 days. The increased uncertainty is due to low concentrations mainly of ^{228}Ra daughter (^{228}Ac). The sensitivity of the applied method for the estimation of the residence time would drastically be improved measuring in a lower gamma-ray background environment.

Conclusions

During the period 2009-2010, a comprehensive study is in progress at the SGD site in Kalogria Bay (SW Peloponnissos). Radioactive tracer techniques are being applied estimating groundwater's residence time by means of HpGe gamma-ray spectrometry, and the water age by means of ^{3}H concentration by LSC method. Also, the application of *in situ* gamma-ray spectrometry method based on "KATERINA" detector offers simultaneously concentrations of ^{40}K (relative to salinity) and ^{214}Bi, ^{214}Pb (relative to radon concentration), which are strongly correlated with the mixing processes between ground and sea water at the SGD site. These long term measurements will also contribute significantly to the estimation of water velocities and water flux rate of the specific SGD source.

References

1 - Burnett W. C. and Dulaiova H., 2006. Radon as a tracer of submarine groundwater discharge into a boat basin in Donnalucata, Sicily. *Cont. Shelf. Res.* 26, 874-884.

2 - Burnett W. C., Peterson R., Moore W. S., and de Oliveira J., 2008. Radon and radium isotopes as tracers of submarine groundwater discharge - Results from the Ubatuba, Brazil SGD assessment intercomparison. *Estuarine, Coast. Shelf. Sci.* 76, 501-511.

3 - Moore, W.S., 2000. Determining coastal mixing rates using isotope radioisotopes. *Cont. Shelf. Res.* 20, 1993-2007.

4 - Moore, W.S., Blanton, J.O. and Joye, S.B., 2006. Estimates of flushing times, submarine groundwater discharge, and nutrient fluxes to Okatee Estuary, South Carolina. *J. Geophys. Res.* 111, C09006.

5 - Tsabaris, C., Bagatelas, C., Dakladas, Th., Papadopoulos, C.T., Vlastou, R., Chronis, G.T., 2008. An autonomous in situ detection system for radioactivity measurements in the marine environment. *App. Radiat. Iso.*, 66, 1419-1426.

6 - Tsabaris C., Scholten J., Karageorgis A.P., Commanducci J-F., Georgopoulos D., Kwong L-L.W. and Papathanassiou E., 2009. Application of an in situ underwater gamma spectrometer as a marine radon progeny monitor: continuous monitoring of groundwater discharges into the coastal zone. *J. Environ. Radioactiv.*, submitted

HOLOCENE SEA LEVEL CHANGES OF HISARONU GULF, SOUTHEASTERN AEGEAN SEA

Atilla Ulug [1]* and Nilhan Kaser [1]
[1] Dokuz Eylul University Institute of Marine Sciences and Technology, 35340, Izmir, Turkey - atilla.ulug@deu.edu.tr

Abstract
The relative sea level change during the Holocene geologic times for the Hisaronu Gulf (SE Aegean Sea) and surroundings were investigated performing high resolution seismic and bathymetric survey. Hisaronu Gulf is affected by sea level rising in the last glacial period (20.000 BP) and local tectonic movements. Comparing with the eustatic sea-level curve and our seismic stratigraphic interpretations considered paleo-shoreline positions, it can be said that the relative sea level change for the Holocene period is result of the tectonic subsidence of the coastal plain.
Keywords: Sea Level, Sedimentation, Tectonics

Introduction
The global eustatic sea level in the Aegean Sea and surroundings in the Late Pleistocene-Holocene time (20.000 yr BP) rose from -120m below present sea level to its modern position because of melting ice sheets since the last glacial period ([1], [2]). The aims of this paper are to describe the seismic units that formed the Hisaronu shelf during the Holocene period from high resolution seismic data and reveal the model of sequence stratigraphic analysis to seismic profiles to interpret the relative sea level change controlled by eustatic rise and local tectonic movements comparing with similar studies performed on Mediterranean coasts.

Study area
The Hisaronu Gulf is bordered by the Datça Peninsula to the north, the Simi Island to the south, and the Bozburun Peninsula to the east (Fig. 1). The Gulf is a part of the western Anatolia – southeastern Aegean Sea regions, which are currently under an N–S regional extensional tectonic framework dominated by the westward escape of the Anatolian plate as a result of collision of the Arabian and African plates with Eurasia ([3]).

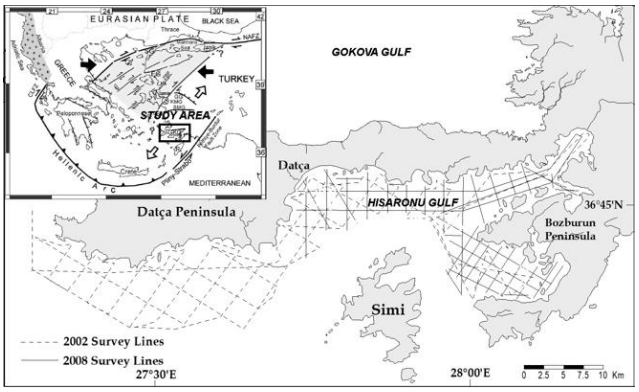


Fig. 1. Bathymetric and seismic line map of the Hisaronu Gulf

Materials and Methods
This study is mainly based on high-resolution seismic reflection profiles using ORE Subbottom Profiler System and using Bathy 2010 Chirp System in 2002 and 2008 with 3.5 kHz frequency collected during a cruise of R/V K. Piri Reis of Institute of Marine Science and Technology (Fig. 1).

Results
The relative sea level changes are the result of eustatic sea level fluctuations and tectonic movements. The seismic sedimentary chronology suggests that the average rate of vertical tectonic movement in Aegean Sea for the last 120.000 years has been around 0.5 mm/yr in Gokova Gulf ([4], [5]). During the Holocene geological times, glacio-eustatic sea level changes formed two major depositional units in the Hisaronu Gulf and surroundings: transgressive systems tract (TST) related to the last post-glacial transgression (20-8 ka); and highstand systems tract (HST), related to the Holocene higher sea level (8 ka to present) ([2]) with maximum 25 ms thickness. The conceptual model of sequence stratigraphy, has been applied to our high resolution seismic data which allows the study of the youngest depositional sequence during the last sea level rise in the Holocene (Fig. 2). By considering the global sea-level curve and paleo-shoreline positions, we found out the relative changing in sea level result from local tectonic movements. Besides eustatic reasons, tectonic subsidence due to the half graben structure of the area is the main trigger of the relative rise in sea level.

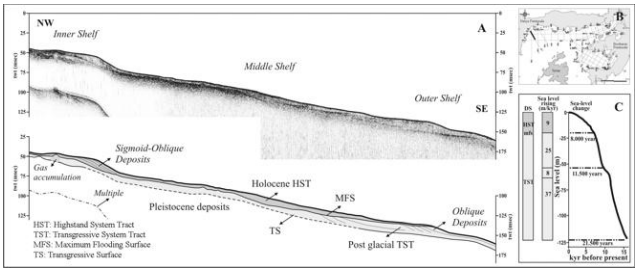


Fig. 2. Seismic reflection profile from Datça Shelf (A) and the chronology of depositional sequences suggested from [2] sea level curve (C).

References
1 - Fairbanks, R.G., 1989. A 17.000-year glacio-eustatic sea level record: influence of glacial melting rates on the Younger Dryas event and deep-ocean circulation. *Nature*, 342: 637-642.
2 - Bard, E., Hamelin, B., Fairbanks, R.G., 1990. U-Th ages obtained by mass spectrometry in carals from Barbados: Sea level during the past 130000 years. *Nature*, 346: 456-458.
3 - Dewey, J.F., Sengor, A.M.C., 1979. Aegean and surrounding regions. Complex multiplate and continum tectonics in a convergent zone. *Geol. Soc. Am.*, Bull. 90: 84-92.
4 - Kaser, N., 2004, Investigation of Neotectonism in the Southwestern Anatolia by Marine Seismic Data, *MSc. Thesis*, Izmir.
5 - Ulug, A., Duman, M., Ersoy, S., Ozel, E., Avci, M, 2005. Late Pleistocene sea level change, sedimentation and neotectonics of the Gulf of Gokova: Southeastern Aegean Sea. *Mar. Geo.* 221: 381-395.

NEW CONSTRAINTS ON MESSINIAN SEALEVEL DRAWDOWN FROM 3D SEISMIC DATA OF THE EBRO MARGIN, IBERIAN PENINSULA, AND IMPLICATIONS FOR EVOLUTION OF THE EBRO BASIN

R. Urgeles [1]*, A. Camerlenghi [2], D. García-Castellanos [3], B. De Mol [4], M. Garcés [5] and J. Vergés [3]
[1] Institut de Ciencies del Mar (CSIC), 08003, Barcelona, Spain - urgeles@icm.csic.es
[2] Universitat de Barcelona ICREA, 08010, Barcelona, Spain
[3] Institut de Ciències de la Terra "Jaume Almera" (CSIC), 08028, Barcelona, Spain
[4] Universitat de Barcelona and Parc Científic de Barcelona, 08028, Spain
[5] Universitat de Barcelona, Departament de Geologia Dinàmica, Geofísica i Paleontologia, 08071, Spain

Abstract
In this study 3D seismic and well data from the Ebro Margin, NW Mediterranean Sea are used in combination with backstripping and coupled isostasy and river transport and drainage evolution modeling techniques. The objective is to present new lights on the origin and sedimentary processes that took place on the Messinian Erosion Surfaces (MES) of the Valencia Trough (Mediterranean Sea), to provide a minimum estimate of the sea level fall in the Ebro Margin and to offer new constraints on the evolution of the adjacent subaerial Ebro Basin.
Keywords: Continental Margin, Erosion, Evaporites, Messinian, Models

The recognition of subaerial erosional surfaces at the rims of the Mediterranean basin has been one of the first and strongest evidences put forth to support the hypothesis of an exceptional Messinian sea level low stand that exceeded substantially any possible eustatic change (e.g., [1]). This study builds on a large 2700 km^2 3D seismic survey, which provides unprecedented detail and areal coverage of the Messinian Erosion Surface (MES) on the Ebro margin. The aim of this paper is to present new lights on the origin and sedimentary processes that took place on the MESs of the Western Mediterranean Sea, provide a minimum estimate of the sea level fall in the Ebro Margin and offer new constraints on the evolution of the adjacent subaerial Ebro Basin, particularly with regard to the time when full open drainage conditions towards the Mediterranean of this formerly endorheic basin were reached. Four major seismic units are identified on the Cenozoic Ebro Margin, based on the seismic data, including two major prograding megasequences (Serravallian-Tortonian Castellón Group and Pliocene-Pleistocene Ebro Group) that are separated by a major unconfirmity: the MES (see also [2] and [3]). . Offshore, the MES evolves into a paraconformity and is onlapped by shallow water detrital bodies. The 3D seismic data provide an unprecedented view of the MES displaying characteristic features of subaerial incision including a drainage network with tributaries of at least five different orders, terraces and meandering rivers. The Messinian landscape of the Ebro Margin presents a characteristic stepped-like profile that allows to subdivide the margin in three different regions roughly parallel to the Present Day coastline. Such a stepped profile is also evident in numerous areas of the Mediterranean Sea [4, 5]. No major tectonic control exists on the boundary between the different regions. The boundary between the two most distal regions can be identified to mark the location of a relatively stable water table, and this is used in backstripping analysis to identify the sea level drop associated with the Messinian Salinity Crisis on the Ebro Margin: in the order of ~1300 m, in agreement with the maximum amount of fluvial incision on the margin. The MES on the Ebro Margin is dominated by a major fluvial system. The observed width of the channel and modelling results suggests that this major valley corresponds to the Messinian Ebro River that should have already attained a drainage area comparable to the present one. Constraints provided by the data set, onshore geology and coupled isostasy and river transport and drainage evolution modeling techniques indicate that drainage of the Ebro River into the Mediterranean Sea occurred prior to the Messinian, most probably during the Serravallian/Tortonian, which is the age of the first significant >1-km thick siliciclastic deltaic megasequence deposited in the Ebro Margin.

References
1 - Ryan W.B.F., 2008. Decoding the Mediterranean salinity crisis. *Sedimentology*, 56: 95-136.
2 - Bertoni C. and Cartwright J., 2005. 3D seismic analysis of slope-confined canyons from the Plio-Pleistocene of the Ebro Continental Margin (Western Mediterranean), *Basin Research*, 17: 43-62.
3 - Frey-Martínez J., Cartwright J.A., Burgess P.M. and Vicente-Bravo J., 2004. 3D seismic interpretation of the Messinian Unconformity in the Valencia Basin, Spain. *In*: Davies R.J., Cartwright J.A., Stewart S.A., Lappin M., Underhill J.R. (eds.), 3D Seismic Technology: Application to the Exploration of Sedimentary Basins, pp. 91-100. Geological Society, London, Memoirs, 29.
4 - Bertoni C. and Cartwright J., 2006. Controls on basin-wide architecture of Messinian salt deposits, eastern Mediterranean. *Sedimentary Geology*, 188–189: 93–114.
5 - Lofi J., Gorini C., Berne S., Clauzon G., Dos Reis A.T., Ryan W.B.F. and Steckler M.S., 2005. Erosional processes and paleo-environmental changes in the western Gulf of Lions (SW France) during the Messinian Salinity Crisis. *Mar. Geol.*, 217: 1-30.

GEOMORPHOLOGICAL EVIDENCES OF CATASTROPHIC WAVES IMPACT IN SOUTHERN LESVOS (NE AEGEAN SEA)

Matteo Vacchi [1]*, Alessio Rovere [1], Nickolas Zouros [2] and Marco Firpo [1]
[1] DipTeRis, Department for the Study of the Territory and its Resources, University of Genova. Italy - matteo.vacchi@unige.it
[2] Faculty of Geography, University of Aegean. Mytylene, Lesvos Island (Greece)

Abstract
Eastern Mediterranean and in particular the Aegean Sea have been often affected by catastrophic events such as strong earthquakes and related tsunamis. However, field evidences of tsunamis from the late Holocene are quite rare. This study, carried out in southern Lesvos Island (NE Aegean), individuated a large accumulation of boulders dislocated by tsunami events providing important information concerning the current coastal hazard of the area.
Keywords: Aegean Sea, Coastal Processes, Waves, Coastal Management

Geomorphological evidences of past catastrophic events represent an important tool to assess the current hazards, especially in coastal areas. In particular, large boulder deposits have been often used to determine wave heights, age of deposition, magnitude and frequency of extreme waves or tsunami events along the Mediterranean coasts [1]; [2]; [3]. Due to its tectonic setting, the Aegean Sea region is particularly susceptible to earthquakes and related tsunamis but few field evidences of the impacts of these catastrophic waves are reported in literature [4] This study was carried out in Lesvos Island (NE Aegean), the third largest Greek island with an area of 1,630 km^2 and about 300 kilometres of coastline. In particular, the study area is located in the southern part of the island, between the towns of Plomari and Vatera, where the coastline develops for more than 30 km, being characterised by high cliffs and large sandy beaches, often interrupted by beachrocks outcrops. Here, a big amount of large boulders (up to almost 15 t) were individuated in four sites having different geomorphologic and geological frameworks. Direct observations on each boulder were carried out in order to measure it (size and weight, distance and elevation respect the shoreline) and individuate the pre-transport setting (underwater or sub-aerial position) [5]. A further survey of their long axis orientation and distribution was carried out in order to recognise the geographical origin of the waves. The Nott [5] approach was applied to understand if the boulders displacement was compatible with the local storm wave regime or if they were dislocated by tsunami events. The orientation of elongated boulders allowed to detect two main provenience of the catastrophic waves, one comprised between 150N and 180N and the second between 210N and 240N. The study of wind-wave climate of the area excluded a surge storm origin as cause of the large boulder accumulation. A tsunamitic origin was then attributed to the studied blocks. Moreover, the bimodal distribution suggested that two different events could have affected the area and further datation on the fossil material found on the boulders (bryozoa, vermitids, serpulids) could confirm this hypothesis. The radiometric datation will also allow to confront the events with the historical ones present in different Greek and Mediterranean tsunamis catalogues [6]; [7]. In conclusion, this study provided new and important information in terms of current level of coastal hazard in southern Lesvos and, in particular, in Plomari, the second largest town of the island, with almost 5000 inhabitants where the results should be converted to recommendations for the local governments in order to plan different activities for the mitigation of the vulnerability.

References

1 - -Mastronuzzi and Sansò, 2000. Boulders transport by catastrophic waves along the Ionian coast of Apulia (southern Italy). *Mar. Geol.*, 170: 93-103
2 - -Scicchitano G., Monaco C., Tortorici L. 2007. Large boulder deposits by tsunami waves along the Ionian coast of south-eastern Sicily (Italy). *Mar. Geol.*, 23: 75–91
3 - -Vött A., Brückner H., Brockmüller S., Handl M., May S.M., Gaki-Papanastassiou K., Herd R., Lang F., Maroukian H., Nelle O., Papanastassiou D. 2009. Traces of Holocene tsunamis across the Sound of Lefkada, NW Greece. *Global Planet. Change*, 66: 112–128
4 - -Scheffers A., Kelletat D., Vött A., May S.M., Scheffers S. 2008. Late Holocene tsunami traces on the western and southern coastlines of the Peloponnesus (Greece). *Earth Plan. Sci. Lett*, 269: 271-279
5 - -Nott, 2003. Waves, coastal boulder deposits and the importance of the pre-transport setting. *Earth Plan. Sci. Lett.*, 210: 269-276
6 - -Papadopoulos and Chalkis, 1984. Tsunami observed in Greece and the surrounding area from antiquity up to present. *Mar. Geol.*, 56: 309-317.
7 - -Soloviev, 1990. Tsunamigenic Zones in the Mediterranean Sea. *Nat. Haz.* 3: 183-202.

SEDIMENTARY INSTABILITIES ALONG THE SOUTHWESTERN SLOPE OF THE ALBORAN RIDGE (SW MEDITERRANEAN)

J. T. Vazquez [1], P. Bárcenas [2], D. Palomino [1], B. Alonso [3]*, G. Ercilla [3], V. Díaz Del Río [1], N. López-González [1], L. M. Fernández-Salas [1] and M. Sayago-Gil [1]

[1] Instituto Español de Oceanografía, Puerto pesquero s/n, 29640 - Fuengirola, Málaga (Spain)

[2] Dpto. Análisis Matemático, Universidad de Málaga, Málaga (Spain)

[3] Instituto de Ciencias del Mar, CSIC, Barcelona (Spain) - belen@icm.csic.es

Abstract

Detail reprocessing and analysis of a multibeam bathymetric data set and seismic profiles have allowed identified several complexes of sedimentary instabilities along the southeastern flank of the Alboran Ridge. A Large Slope Apron System could be defined in this area that includes isolated slides, complex of slides and slope apron systems. These features show different sizes and evolutionary stages. Seismicity and the Quaternary tectonic activity are considered the main factors controlling their development.

Keywords: Geomorphology, Sedimentation, Tectonics, Alboran Sea, Western Mediterranean

Introduction

The development of sedimentary instabilities and mass movements on active tectonic reliefs has been described frequently [1, 2]. The Alboran Ridge is the most relevant physiographic feature of the Alboran Sea Basin, it extents along approximately 200 km in a WSW-ENE trend and is constituted by five aligned seamounts. This complex feature is a tectonic relief uplifted from the Miocene to the Quaternary, by means of folding, lateral and compressive faulting, and volcanism. The structure of the Alboran Ridge has been described as a main anticline bounded by oblique left-lateral/reversed faults [3]. Nowadays, only few sedimentary instabilities have been analyzed in the Alboran Basin [4], but a more important development can be expected.This study focuses on the sedimentary instabilities occurred on the southern flank of the farthest east seamount of the Alboran Ridge. Several methods were used to investigate these features including multibeam bathymetry and a scarce net of ultrahigh (Sub-bottom Profiler and TOPAS systems) and high (Airguns) resolution seismic profiles.

Results and discussion

Sedimentary instabilities have been identified along both flanks of the Alboran Ridge, northeastern and southwestern. Their occurrence has been recognized based on features indicative of the disappearance of sediments and of deformational features. The southeastern flank forms an abrupt scarp (6-10 km wide) that extends between 70 to 1050 m water depths and displays average slope gradients between 8 and 18º. Both types of features, mass-movement deposits (from slides to turbidites) and valleys (canyons and channels) are identified. The following systems have been differentiated based on genetic processes and relationships (Fig. 1): isolated slides (box 2), complexes of slides (boxes 1 and 4), and slope apron systems (boxes 3 and 5). The slide scars are mainly located at upper part of the flank (70-140 m) where gradients average 20º, and have lengths between are 1.5 and 7 km.

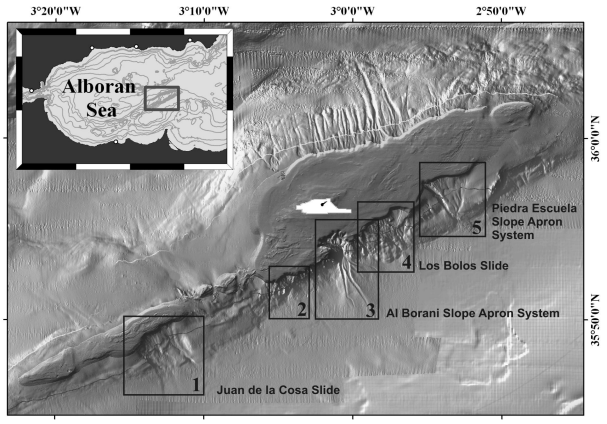


Fig. 1. Bathymetric map of eastern Alboran Ridge segment illustrating the different systems of sedimentary instabilities (Boxes 1 to 5) identified in the southern flank.

The complexes of slides have lengths between 1.8 and 6.6 km, and comprise concomitant slides, some remain on the surface but mostly extend from the slope break toward the Southern Alboran Basin where the deformed and disrupted slide material deposits forming lobes/wedges of chaotic facies with a rough seafloor surface (boxes 1 and 4).Thus, these complexes would represent slides and associated mass-flows deposits.

Two types of slope apron systems are identified based on their internal sediment source that conditions the resulting architecture: point source apron (box 3) and multiple source apron (box 5). The point source apron (box 3) comprises a submarine canyon (3.5 km length) whose head indents into the summit of the ridge and extends down to the break of slope and from that point develops a turbiditic apron (5 km wide, 7.5 km length) defined by chaotic facies with numerous shallow channels (6 km length). The multiple source apron (box 5) comprises several channel systems of different orders of magnitude that extends downslope from the summit of the flank and converge at 870 m water depth, a little before to reach the break of slope of the flank, and develops a depositional turbiditic apron (4 km wide, 5.7 km length) from that point spreads to the Southern Alboran Basin.

From a sedimentary point of view, the southern flank of The Alboran Ridge forms a Large Slope Apron System that is made up of minor-order systems consisting of both constructional and erosional architectural elements. All these elements reflect the occurrence of sedimentary instabilities associated to the general mass-wasting process that affects to the southern flank of the ridge. The continuous moderate seismic activity in the Alboran Sea region and the Quaternary tectonics of the Alboran ridge must be invoked as the main controlling factors of this intensive mass wasting.

Acknowledgements: This is a contribution of the DEEPER (IEO) and MONTERA (CTM2009-14157-C02) projects.

References

1 - McAdoo, B.G. and Watts, P., 2004. Tsunami hazard from submarine landslides on the Oregon continental slope. *Mar. Geol*,, 203(3-4): 235-245.

2 - Rebesco, M., Neagu, R.C., Cuppari, A., Muto, F., Accettella, D., Dominici, R., Cova, A., Romano, C. and Caburlotto, A., 2009. Morphobathymetric analysis and evidence of submarine mass movements in the western Gulf of Taranto (Calabria margin, Ionian Sea). *Int. J. Earth Sci.*, 98: 791-805.

3 - Watts, A.B., Platt, J.P. and Buhl, P., 1993. Tectonic evolution of the Alboran Sea basin. *Bas. Res.*, 5 (3): 153-177.

4 - Ercilla, G., Estrada, F., Yenes, M., Casas, D., Alonso, B., Farran, M. and SAFAS TEAM., 2009. The Baraza slide, defining its dynamic. International Conference on Seafloor Mapping for Geohazard Assessment. *Ischia Island Rend. Online Soc. Geol. It., pp. 163-165.*

MAGNETIC SIGNATURE OF ADRIATIC SEDIMENT FROM LATE GLACIAL TO PRESENT: NEW INSIGHTS FOR THE BASIN EVOLUTION

Luigi Vigliotti [1]*, Annamaria Correggiari [1] and Andrea Gallerani [1]
[1] CNR Ismar Bologna, 40129, Italy - luigi.vigliotti@bo.ismar.cnr.it

Abstract
Changes in the depositional environment of the Adriatic Sea during the late Glacial-Holocene sea-level rise have been investigated by means of magnetic measurements. Both concentration and grain size dependent parameters show a different magnetic signature that reflect differences in the source area of the sediments and diagenetic processes as well as modification in the shape of the basin.
Keywords: Adriatic Sea, Geomagnetism, Sea Level, Sedimentation

Rock-magnetic techniques applied to marine deposits provide informations about the amount, the grain size and the mineralogy of the magnetic fraction within the sediments. In a first instance, these properties are a function of the supply of the clastic fraction, but they also represent post-depositional processes occurring within the sediment. So they reflect physical changes in the depositional environment that are strictly related to paleoclimatic and paleoceanographic changes as well as human environmental impact. In this study we present the results of natural (magnetic susceptibility, X) and laboratory-imparted rock magnetic properties such as anhysteretic (ARM) and isothermal (SIRM) remanence measured from marine cores collected in the

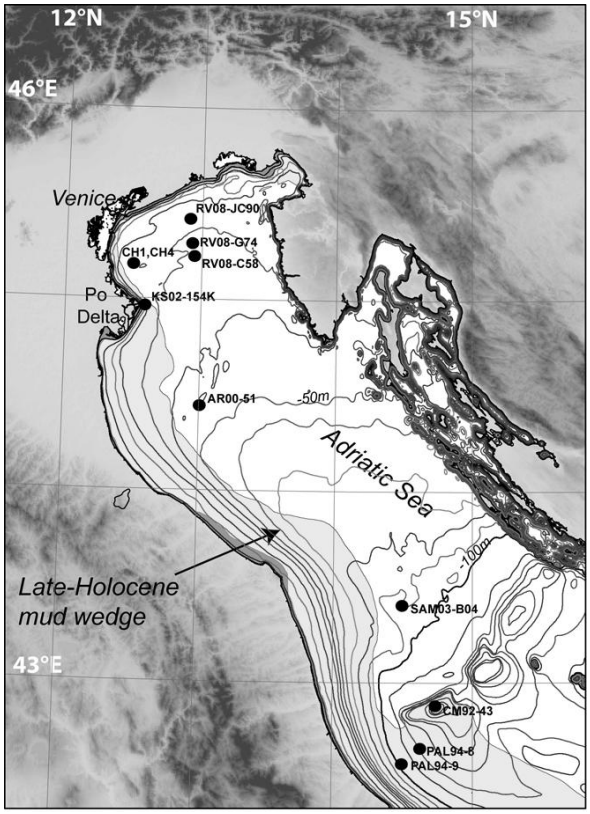


Fig. 1. Location map of the studied cores and Late-Holocene mud wedge areal distribution dated post 5.5 kyr.

Adriatic Sea from the northern shelf to the Mid Adriatic Depression (MAD) (Fig.1). The studied parameters are indicative of magnetic concentration, but they are sensitive to different grain size implying that interparametric ratios (i.e. SIRM/ARM) are indicative of change in grain-size. The Late Pleistocene-Holocene age of the cores is constrained by the stratigraphic framework of the area supported by C^{14} datings and paleomagnetic record of the secular variations of the earth magnetic field. During the Last Glacial Maximum (LGM), a wide part Adriatic shelf was subaerially exposed. The drainage network on this large alluvial plain likely comprised the paleo Po as the main river, with the Alpine and Apenninic rivers as tributaries. With the postglacial sea-level rise, the low shelf gradient (40 m/100 km), and low sediment input, favors significant landward shifts of depositional environments. The late Holocene Po delta formed after the present sea-level highstand represents a major component of the rapidly accumulated mud wedge that with the contribution of Appenine rivers stretches for 600 km along the Adriatic italian coast. In the northern part of the basin rivers from the Venetia-Friulan plain (Adige, Piave, Tagliamento) control the sedimentation. As the catchment of these rivers are different it is expected that the magnetic signature in the sediments reflect the primary signal when diagenetic processes do not introduce significant alterations. The differences are confirmed by mineralogical data showing a significant presence of dolomites in the sediments collected in the northern shelf. The results from recent sediments obtained from a core retrieved in the Po Delta were used as reference signature and compared with the results from other cores. Concentration-dependent parameters (X, ARM, SIRM) point out to an increasing contribution of ferromagnetic minerals in the sediments belonging to the Po with respect to the other sources. The magnetic properties also indicates a time-dependent signature of both concentration and grain size that represent a signature of the different physiographic conditions of the basin during the Late Glacial/Holocene times. Coarse grained detrital magnetite (high SIRM, X and SIRM/ARM values) characterizes Late Glacial deposits from Central Adriatic with an increasing contribution of fine grained magnetic materials
during the Holocene (high ARM, low SIRM/ARM values) (Fig. 2) with peak values after the maximun flooding [1]. The dominance of finer materials reflects the increasing contribution of bacterial magnetite to the remanence of the younger sediments, but could be also related to the landward shift of the source area of the terrigenous input during Holocene time.

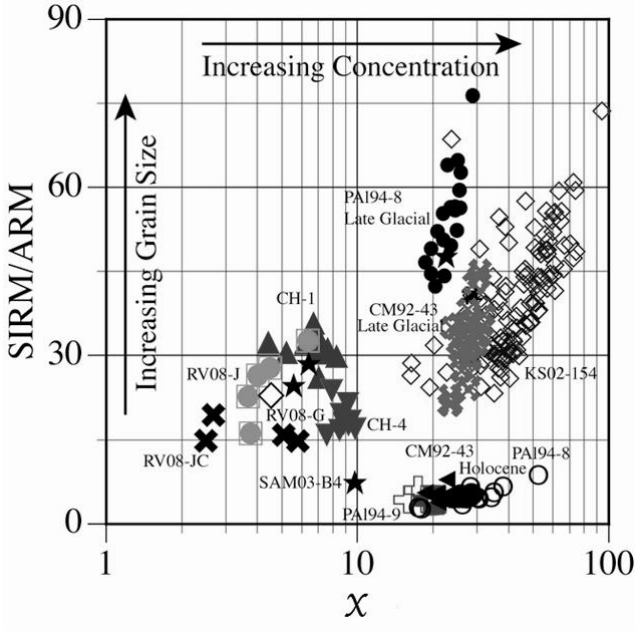


Fig. 2. Plot of mass specific magnetic susceptibility (units: $10^{-9}m^3kg^{-1}$) vs SIRM/ARM for the studied samples.

References

1 - Vigliotti L., Verosub K.L., Cattaneo A., Trincardi F., Asioli A. and Piva A.. 2008. Palaeomagnetic analysis of Holocene deposits from the Adriatic: detecting short term fluctuations in sediment supply. *The Holocene,* 18, 1, 141-152.

THE ROLE OF GROUNDWATER AND RECIRCULATED SEAWATER IN THE TRANSPORT OF NUTRIENTS TO THE COASTAL WATER, A CASE STUDY FROM THE CARMEL COAST, ISRAEL

Y. Weinstein [1]*, B. Herut [2], Y. Shalem [1], Y. Yechieli [3], W. Burnett [4] and P. Swarzenski [5]
[1] Bar-Ilan University, Ramat-Gan, 52900, Israel - weinsty@mail.biu.ac.il
[2] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa 31080, Israel
[3] Geological Survey Of Israel, Jerusalem, 9550, Israel
[4] The Florida State University, Dept of Oceanography, Tallahassee, FL 32306, USA
[5] U.S. Geological Survey, Denver, CO 80225, USA

Abstract

A study of nutrient concentrations in Dor Bay suggests that the groundwater discharging directly to the bay is a mixture of three components: (1) nitrate and silica-rich groundwater, (2) nitrate and silica-depleted recirculated seawater, (3) depleted saline water (salinity of 31), which is the result of mixing between recirculated seawater and denitrified fresh groundwater. Subterranean estuarine processes are reflected just in the slightly elevated concentrations of ammonium and possibly phosphate in the discharging water. This suggests that the nutrients are being mainly carried to the bay by the fresh groundwater, while the role of recirculated seawater in this conveyor is merely secondary.

Keywords: Coastal Processes, Estuaries, Hydrology, Eastern Mediterranean, Nutrients

Submarine Groundwater Discharge (SGD) is now widely accepted as a major factor affecting coastal water quality. More specifically, it was suggested by several authors [1,2] that the recirculation of seawater and the mixing with fresh groundwater in the aquifer (the 'subterranean estuary') is a dominant factor in the transport of some nutrients and other solutes to the sea. During 2006-8, we conducted a detailed study of the composition of groundwater discharging from the sea floor at Dor Bay (Carmel coast, northern Israel). As detailed below, our results suggest that while fresh groundwater is a major source of nutrients to the coastal water, recirculated seawater, even when mixed with fresh groundwater, carries a relatively small amount of nutrients to the sea. Two different geological units are discharging to Dor Bay, a Pleistocene calcareous sandstone (locally called 'Kurkar') and an overlying Holocene sand unit. The two are hydrologically separated by a confining clay unit. ^{222}Rn time series and seepage meter studies suggest that SGD at Dor is on the order of 10 cm/d, and that about half of it is recirculated seawater. Based on radon and salinity, it was established that fresh goundwater discharge was mainly from the underlying Kurkar unit, while seawater recirculation was restricted to the shallow sand. Nitrate concentrations were high in onshore groundwater and very low in the bay water (200-400 and <3 µM NO_3+ NO_2, respectively). The concentrations in water discharging from seepage meters deployed on the bay floor were at the mid range (2-130 µM NO_3+ NO_2). On a diagram of nitrate versus salinity, all discharging water plot in a narrow zone between two mixing lines that meet at the high-nutrient fresh water end. Silica concentrations also suggest mixing between nutrient-rich groundwater (100-400 µM) and nutrient-poor seawater. These results suggest that the groundwater discharging to Dor Bay is composed of three components: (1) nutrient-rich Kurkar groundwater, (2) nutrient-depleted recirculated seawater and (3) nutrient-depleted water with salinity of 31. Component (3) is probably the result of mixing between recirculated seawater and fresh groundwater that underwent denitrification. We identify the latter as sand groundwater, which likely resided for a relatively long time in the bay sediments. This implies that in Dor Bay, nitrates and silica are conveyed to the sea just by the fresh groundwater (which also suffered partial denitrification), and that seawater recirculation and its subterranean mixing with fresh water have no effect on nitrate and silica mobilization. Phosphate was very low both in the seawater and in the Kurkar groundwater, while relatively high in the sand groundwater (0.1-0.2 and up to >4 µM, respectively). Seepage meter water contained up to >1 µM of PO_4, probably due to a contribution from the sand groundwater or to the recirculation of seawater in the subterranean estuary. Similarly, ammonium was quite low both in bay water and in all onshore groundwater ($\leqslant$4 µM), while higher in saline groundwater and in water discharging from the bay floor (up to 20 µM), obviously due to seawater recirculation. However, it was still one order of magnitude lower than the nitrate concentrations in these water samples. To conclude, the main conveyor of nutrients (nitrate and silica) to Dor Bay is the fresh groundwater, while the effect of seawater recirculation in the subterranean estuary is restricted to a relatively small load of ammonium, may be also of phosphate, that is carried by the discharging water. Low nutrients in the recirculated seawater as compared with the fresh groundwater were also reported from other SGD sites (e.g. [3,4]). However, in other cases (e.g. northern Gulf of Mexico) recirculated seawater was characterized as nutrient-rich [5]. It is suggested that the difference between the SGD sites is in their nutrient source. While at Dor and similar sites, nutrients are mainly land-derived, thus bwing mainly transported by fresh groundwater, the nutrients at other sites are derived by remineralization of marine organic matter in the subterranean estuary [5], thus being enriched both in the fresh groundwater and in the recirculated seawater.

References

1 - Moore W.S. 1996. Large groundwater inputs to coastal waters revealed by ^{226}Ra enrichments. *Nature*, 380, 612-614.

2 - Moore, W.S. 1999. The subterranean estuary: a reaction zone of ground water and sea water. *Marine Chemistry*, 65, 111-125.

3 - Mutchler, T., Dunton, K.H., Townsend-Small, A., Fredriksen, S. and Rasser, M.K. 2007. Isotopic and elemental indicators of nutrient sources and status of coastal habitats in the Caribbean Sea, Yucatan Peninsula, Mexico, *Estuarine Coastal and Shelf Science*.74, 449-457.

4 - Leote, C., Ibánhez, J.S. and Rocha C. 2008. Submarine Groundwater Discharge as a nitrogen source to the Ria Formosa studied with seepage meters. *Biogeochemistry*, 88(2), 185-194.

5 - Santos, I.R., Burnett, W.C., Dittmar, T., Suryaputra, I.G.N.A. and Chanton, J.P. 2009. Tidal pumping drives nutrient and dissolved organic matter dynamics in a Gulf of Mexico subterranean estuary. *Geochimica et Cosmochimica* Acta, 73, 1325-1339.

A MARINE ENVIRONMENT INTERDISCIPLINARY OBSERVATORY IN THE EASTERN LIGURIAN SEA

M. Abbate [1], A. Bordone [1], G. Cerrati [1], S. Cocito [1], F. Conte [1], R. Cupido [1], R. Delfanti [1]*, V. Difesca [1], A. Lisca [1], C. Lombardi [1], A. Negri [1], A. Peirano [1], P. Picco [1] and S. Sgorbini [1]

[1] ENEA, Marine Environment Research Centre, La Spezia, Italy - roberta.delfanti@enea.it

Abstract

Since the 90' ENEA CRAM is involved in the environmental monitoring of the Eastern Ligurian coastal marine ecosystem. The observatory includes meteo-marine observations from fixed platforms (meteorological station, buoys and moorings), at sea campaigns with in situ sampling and underwater surveying of benthic and pelagic communities. The aim is to control the evolution of environmental conditions for climatic studies as well as for the management of the coastal area. The long-term observations allowed to detect the "intrusion" of alien and harmful invasive species favored by the warmer surface water temperatures, and to approach a comprehensive study of the mortality events which affected benthic species in this area.

Keywords: Monitoring, Time Series, Coastal Systems, Ligurian Sea

Since the 90' ENEA CRAM is involved in the environmental monitoring of the Eastern Ligurian coastal marine ecosystem within ELIOS (Eastern Ligurian Interdisciplinary Observing System). In addition to the scientific need to monitor coastal ecosystem changes and predict future trends, there is an increasing request to provide data for a science-based management of a coastal zone subject to increasing anthropogenic pressures. This observation network offers an ideal platform to study specific processes characterized by seasonal and higher temporal resolution time scale.

Within ELIOS, the monitoring activities are carried out multidisciplinary. The meteo-marine conditions are provided by integrating different systems of measurements, to ensure the necessary spatial and temporal resolution including: a coastal meteorological station [1] measuring wind speed and direction, solar radiation, air temperature, relative humidity and atmospheric pressure, precipitation; a shelf sea meteo oceanographic buoy located at a sea depth of 28 m providing meteorological measurements, sea temperature, salinity, fluorescence, oxygen and ph profiles in the upper 25 m of the water column; an oceanographic mooring deployed at 30 m depth providing currents, temperature and salinity measurements at 15 m and 25 m depth. Some autonomous temperature sensors have also been fixed to the rocks. Repeated (weekly during summer) synoptic surveys in the Gulf of La Spezia include temperature, salinity, fluorescence, profiles; nutrients and turbidity (Secchi-disk) in the water column and sampling of phytoplankton. Open-sea meteo oceanographic observations (atmospheric parameters, sea temperature and salinity, ADCP currents profiles in the thermocline) are available from the meteo-oceanographic buoy ODAS ITALIA 1 located in the Central Ligurian Sea and form the oceanic mooring deployed nearby. Benthic communities (coralligenous and *Posidonia* meadows) and the presence of invasive and harmful species (*Ostreopsis ovata*) are regularly investigated through underwater surveys and sampling at fixed locations.

Data collected by the two buoys allowed to investigate thermal anomalies below the sea surface, how these affected at different degree the coastal and the open sea area and to follow the evolution and the response of the ocean-atmosphere system to that particular event. In particular, the persistence of calm weather conditions caused a sea temperature anomaly of about 4 degree down to 25 m. Twelve-year monitoring of gorgonian population trends allowed to analyse population size structure, colony and recruitment density of a damaged *Paramuricea clavata* population after 1999 and 2003 mortality events and to identify changes in biological, ecological and demographic features [2]. This population supplies a paradigmatic example of the response of a population living from 16 to 25 m depth, thus near the edge of the summer thermocline, to the mortality associated to anomalous temperature increase. The high colony recovery and recruitment rates found (4 fold increase) suggest a good resilience for this population due to the reproductive output of the smaller-younger colonies [3]. Nevertheless, its geographical isolation, together with an increased frequency of mortality events, could challenge its persistence.

The long-term observations allowed to detect the "intrusion" of alien and harmful invasive species favored by the warmer surface water temperatures. In the Gulf of La Spezia the first *Ostreopsis ovata* bloom took place during the hot summer of 1998. When meteo-marine conditions favourable to *O. ovata* development, mainly high temperature and flat sea, persisted for weeks blooms took place with the production of millions of cells causing hypoxia and sometime damage to human health. On the contrary, rough sea and waves caused a sharp reduction of *O. ovata* density.

This observing system, providing a continuous environmental and meteo-marine monitoring, allows a better understanding of the sensitivity of marine organisms and communities to the rapid changes of the environmental conditions, particularly in time of climate change. In addition, the real time surveillance could support local administrators in the management of navigation and environmental emergencies.

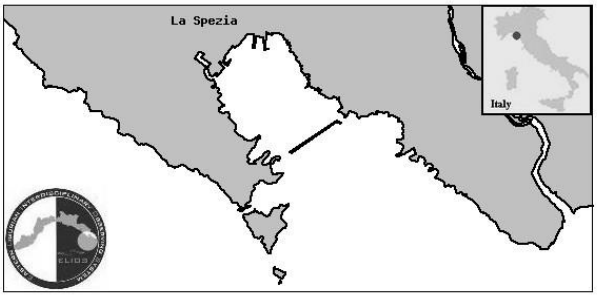


Fig. 1. Location of the observing system in the Eastern Ligurian Sea

References

1 - Picco P., Bozzano R., Schiano M.E., Bordone A., Borghini M., Di Nallo G., Schirone A. and Sparnocchia S., 2007. Marine Observing Systems from fixed platforms in the Ligurian Sea. *Boll. Geof. Teor.Appl.*, 48: 227-240

2 - Cupido R., Cocito S., Bordone A., Sgorbini S. and Santangelo G., 2008. Response of a gorgonian (*Paramuricea clavata*)population to mortality events: recovery or loss? *Aquat Conserv: Mar Fresh Ecosyst* 18: 984-992.

3 - Cupido R., Cocito S., Barsanti M., Peirano A. and Santangelo G. 2009. Unexpected long-term population dynamics in a canopy-forming gorgonian following mass mortality. *Mar. Ecol. Prog. Ser.* (doi: 10.3354/meps08260)

MODEL ESTIMATES OF M_2 INTERNAL TIDE ENERGETICS IN THE SICILIAN CHANNEL

Jihene Abdennadher [1]* and Moncef Boukthir [1]
[1] Institut Preparatoire aux Études d'Ingenieurs de Tunis, Montfleury, Tunisia - jihene.abdennadher@ipeit.rnu.tn

Abstract
The M_2 internal tide energetics in the Sicilian channel have been investigated by using a three-dimensional sigma coordinate model (ROMS). Realistic topography and stratification from existing observations were used. We have identified three potential sites of M_2 internal tide generation, namely the western sill of the Adventure Bank, northwest of Sicily and north of Pantelleria isle. The conversion rate from the M_2 surface to internal tide energy integrated over the whole model domain amounts to 47.5 MW, 75 % of which are found to be generated over the three prominent topographic features mentioned above
Keywords: Tides, Sicilian Channel

Introduction
The Strait of Sicily has been extensively studied during the last years [1, 2]. However, very few is known about the generation of the internal tide in this strait. Indeed, except sparse observations [3, 4], the vertical structure has not been sufficiently addressed. Within the framework of what has previously been studied concerning the internal tides generation and propagation in some potential areas, we try to clarify the distribution of the M_2 internal tides in the Strait of Sicily as well as its energetics. We use a fully three-dimensional sigma coordinate model, the Regional Ocean Modeling System (ROMS). The horizontal resolution is 1/32° in both longitudinal and latitudinal directions.

Internal tidal energy budget
The governing equation for the baroclinic energy is given by

$$\frac{\partial}{\partial t}\left(\bar{\rho}_0\frac{\vec{u}_i^2}{2}+\frac{g\rho'^2}{2}\left(-\frac{d\rho_0}{dz}\right)^{-1}\right)=-\vec{\nabla}\cdot(p_i\vec{u}_i)+g\rho' w_{bt}+D+A \quad (1)$$

where $\bar{\rho}_0$ is the reference water density, ρ_0 is the background basic density stratification, ρ' is the water density perturbation, $\vec{u}_i$ is the baroclinic velocity, w_{bt} is the vertical velocity induced by the barotropic tide flow, p_i is the internal pressure perturbation, D and A denote the dissipation and the advection of the baroclinic energy, respectively. The left side of (1) is the rate variation of the baroclinic energy density, $p_i\vec{u}_i$ is the energy flux that is associated with the propagation of the internal tide, and $g\rho' w_{bt}$ represents the conversion rate from surface to internal tide energy.

Assuming that the advection of baroclinic energy is neglected, integration of the equation (1) over a given domain and taking the average over one tidal period (denoted by an overbar) yields:

$$\iiint g\,\overline{\rho' w_{bt}}dV=\iint\overline{p_i\vec{u}_i}\vec{dS}+\iiint\bar{D}dV$$

The model-predicted distribution of the depth-integrated conversion rate from the M_2 barotropic to baroclinic tidal energy shows that there are three distinct sites of strong generation, one at the narrowest passage through the western sill of the Adventure Bank, and the two others are in the northwest of Sicily and the north of the Pantelleria isle. The M_2 mode conversion integrated over these prominent topographic features sums up to 35.6 MW, which is 75% of that integrated over the whole model domain. M_2 internal tide is mostly efficient over the narrowest passage through the western sill where the baroclinic energy conversion amounts to 17.1 MW. It is about 11.3 MW in the northwest of Sicily and 7.2 MW in the north of the Pantelleria isle. The net M_2 baroclinic energy flux away from the region including the western sill accounts for 8.5 MW, 5.5 MW of which is directed toward the north and 3 MW toward the south. For the region including the Pantelleria isle, the energy flux divergence has been estimated to be 60% of the integrated conversion energy, mainly directed toward the Tunisian coasts (2.6 MW).

The local dissipation within the western sill of the Strait of Sicily amounts to 8.9 MW corresponding to 52 % of the baroclinic energy conversion where it is about 40 % within the north of Pantelleria isle and about 71 % in the northwest of Sicily. It is important to note that 42.3% of the barolinic energy generated in the whole modelled region is dissipated in close proximity to the baroclinic M_2 generation sites already identified.

The baroclinic energy flux divergence (Figure) emphasizes the localised nature of generation and depicts the propagation of energy away from the narrowest passage through the western sill toward the north and southwest. The main direction of propagation from the Pantelleria isle is toward the Tunisian coasts.

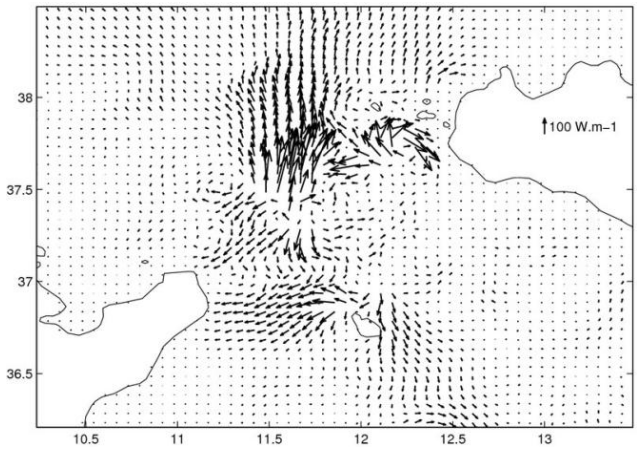


Fig. 1. The depth-integrated M_2 baroclinic energy flux

References
1 - Astraldi, M., Gasparini, G. P., Gervasio, L., and Salusti, E, 2001. Dense water dynamics along the Strait of Sicily (Mediterranean Sea), *J. Phys. Oceanogr.*, 31: 3457-3475.
2 - Beranger, K., Mortier, L., Gaparini, G.P., Gervasio, L., Astraldi, M., and Crépon, M, 2004. The dynamics of the Sicily Strait: a comprehensive study from observations and models, *Deep-Sea Res. I*, 51: 411-440.
3 - Artale V, Provenzale A, and Santoleri R, 1989. Analysis of internal temperature oscillations of tidal period on the Sicilian continental shelf. *Cont. Shelf Res.*, 9: 867-868.
4 - Gasparini, G.P., Smeed, D., Alderson, S., Sparnocchia, S., Vetrano, A., and Mazzola, S, 2004. Tidal and subtidal currents in the Strait of Sicily, *J. Geophys. Res.*, 109: 1-19.

THE MEDITERRANEAN SEA RE-ANALYSIS: 1985-2007

M. Adani [1]*, N. Pinardi [2], S. Dobricic [3], M. Tonani [1], P. Oddo [1], C. Fratianni [1], S. Lyubartsev [1], G. Coppini [1] and I. Pujol [4]
[1] Istituto Nazionale Geofisica e Vulcanologia, Bologna, Italy - adani@bo.ingv.it
[2] Universita' di Bologna, Bologna, Italy
[3] Centro Euro-Mediterraneo per i Cambiamenti Climatici, Bologna, Italy
[4] CLS Space Oceanography Division, Toulouse, France

Abstract

A simulation and two re-analyses from 1985 to 2005 have been produced for the Mediterranean sea circulation using different assimilation schemes: a Reduced Order Optimal Interpolation and a new three-dimensional variational scheme. The general circulation model used is the OPA 8.1 code. The observational data sets assimilated are vertical temperature and salinity in situ profiles and along track satellite sea level anomalies (SLA); daily mean fields of Sea Surface Temperature are used for correcting the fluxes. The results of both reanalysis are comparable and they are qualitatively consistent to the known structures of the circulation in the period of interest.

Keywords: Circulation Models, Inverse Methods

Introduction

Re-analyses are different from analyses because they are consistent for the whole period since the oceanic state estimates are produced without changes in the modelling assumptions and they are usually done with systems, which are more advanced then the available systems at the time of the observations collection. A fundamental part of a re-analysis system is the data assimilation scheme, which minimizes the cost function penalizing the time-space misfits between the data and the numerical solutions, with the constraint of the model equations and their parameters. In this work we will compare ocean circulation estimates provided by pure simulation, a system in which the assimilation scheme is based on a sequential algorithm: Optimal Interpolation (OI) and a three-dimensional variational scheme (3dvar).

Method

The OGCM used in this work is based on OPA 8.1 code [1], which has been implemented in the Mediterranean Sea by Tonani et al.[2]. The model has 1/16th horizontal resolution and 71 unevenly spaced vertical levels. The present model formulation uses a realistic water flux with river runoff that improves the realism of the simulation. One re-analysis is produced with the Reduced Order Optimal Interpolation (ROOI) [3] and the other with OceanVar[4]. The observational data sets assimilated for both reanalysis are: 1) the historical data archive of MedATLAS [5] which contains vertical in situ profiles of temperature and salinity from bottles, XBT, MBT and CTD sensors;2) temperature and salinity profiles collected in the framework of MFSPP and MFSTEP (Mediterranean Forecasting System) projects;3) CLS along track satellite sea level anomaly data from ERS1, ERS2, Envisat, Topex/Poseidon, Jason1 satellites [6]. Reanalyzed daily mean fields of Sea Surface Temperature (SST) from Medspiration [7] and the Delayed-Time operational product of CNR-ISAC have been used to relax the model SST. The Mean Dynamic Topography of Dobricic [8] has been used for both experiments. The model is forced with a combined dataset of ECMWF analysis when available and ERA-15. The precipitations are monthly mean climatology of the NCEP re-analysis [9], the river runoff data are monthly mean climatology from the Global Runoff Data Centre (GRDC) and from Raicich [10] for the minor Adriatic Sea rivers.

Results

Both re-analyses show significantly better results than the simulation reducing both bias and root mean square error even though the structure of the error remains almost the same of the simulation: the largest error for tracers is confined in the thermocline especially in summer, highlighting a problem in the mixing parameterization; the major error for SLA is confined in the most dynamically active areas. Satellite altimetry observations appear to be a fundamental dataset to constrain model solution. Since its homogeneity in the sampling the SLA dataset permits a consistent assessment of the model behaviour. During the years without SLA observations in-situ observations give a less accurate assessment, because their sampling is extremely inhomogeneous both in time and space. The model results permit the recognition of gyres, jets, boundary currents, recurrent eddies, etc, typical of the Mediterranean Sea mean circulation. The results are promising for the detection of the timing of current reversal in the Ionian Sea, the salinity changes and the outflow from the Aegean Straits, its spreading and accumulation phase.

Conclusions

This study describes the development of modelling and data assimilation tools for the production of re-analysis for the entire Mediterranean Sea. In order to carry out a re-analysis two major steps were undertaken in this work. In the first, the general circulation model was upgraded to have the correct air-sea water fluxes. In the second, two assimilation schemes, one new and the other consolidated, were compared to show their impact on the quality of the re-analysis. The general circulation model used in this study is shown to be capable of reproducing quite accurately the ocean dynamics of the Mediterranean Sea. The results have shown that the model solution is in agreement with data and observations, even though some parameterizations of the model should be improved (i.e. heat flux and mixing processes). The new implementation of a realistic water flux, proposed in this study, has improved the model solution so that re-analysis is possible. The study of these re-analysis shows that both products are sufficiently accurate for appropriate climate studies. Both assimilation schemes show good capabilities in correcting the solutions provided by the dynamical model. Moreover the ability of both systems in retaining this information and projecting it in the future has been shown. Eventually, even for very complex non linear systems, with millions of prognostic variables, the equality between the Sequential Kalman Filter Approach and the Variational method as been demonstrated.

References

1 - Madec G., Delecluse P., Imbard M. and Levy C., 1998. OPA 8.1 Ocean general Circulation Model reference manual. Note du Pole de modelisazion, Institut Pierre-Simon Laplace (IPSL), France, 11.

2 - Tonani M., Pinardi N. Dobriicic S., Pujol I. and Fratianni C., 2008. A high-resolution free-surface model of the Mediterranean Sea. *Ocean Sci.*, 4: 1–14.

3 - De Mey P. and Benkiran M., 2000. A multivariate reduced-order optimal interpolation method and its application to the Mediterranean Basin–scale circulation. *In*: Pinardi N. (ed.), Ocean Forecasting, Conceptual Basis and Applications, Springer-Verlag, pp 281-306

4 - Dobricic S. and Pinardi P., 2008. An oceanographic three-dimensional assimilation scheme, *Ocean Model*., 22: 89-105.

5 - Maillard, C. et al., 2003. A Mediterranean and Black Sea oceanographic database and network (MEDAR/MEDATLAS). *in*: Caumette, P. et al. (ed.). The impact of human activities on the marine environment quality and health: the EC impacts cluster: Proceedings of the first workshop (February 2002, Pau, France). pp 89-99.

6 - Pujol M.I. and Larnicol G., 2005. Mediterranean sea eddy kinetic energy variability from 11 years of altimetric data. J. *Marine Syst.*, 58 (3-4): 121-141.

7 - Marullo S., Buongiorno Nardelli B., Guarracino M. and Santoleri R., 2007. Observing The Mediterranean Sea from space: 21 years of Pathfinder-AVHRR Sea Surface Temperatures (1985 to 2005). Re-analysis and validation. *Ocean Sci.*, 3: 299-310.

8 - Dobricic S., 2005. New mean dynamic topography of the Mediterranean calculated from assimilation system diagnostics, *Geophys. Res. Lett.*, 32: L11606.

9 - Kistler, R., Kalnay E., Collins W., Saha S., White G., Woollen J., Chelliah M., Ebisuzaki W., Kanamitsu M., Kousky V., van den Dool H., Jenne R. and Fiorino M., 2001. The NCEP-NCAR 50-Year Reanalysis: Monthly Means CD-ROM and Documentation. *Bull. Am. Meteorol. Soc.*, 82: 247-268.

10 - Raicich F.,1996. On the fresh water balance of the Adriatic Sea, J. *Marine Syst.*, 9: 305-319.

SMALL-SCALE VERTICAL DISTRIBUTION OF ZOOPLANKTON IN THE CATALAN SEA: RELATIONSHIPS WITH PHYSICAL CHARACTERISTICS

M. Alcaraz [1]*, E. Saiz [1], A. Lebourges-Dhaussy [2], R. Graña [3], U. Cotano [4], J. Fernandes [4], S. Isari [1], S. Zamora [1], B. Mouriño [3] and X. Irigoien [4]

[1] Institut de Ciències del Mar, CSIC, Barcelona, Spain - miquel@icm.csic.es

[2] Centre IRD de Bretagne, Plouzané, France

[3] University of Vigo, Vigo, Spain

[4] AZTI Tecnalia, Pasaia, Spain

Abstract

The patterns of the vertical distribution of mesozooplankton in relation to physical and biological heterogeneities were studied in a 5-day time series at a fixed station in the Catalan Sea (NW Mediterranean). CTD, microturbulence, and TAPS® (high-resolution acoustic probe) profiles, and depth-stratified LHPR® hauls from 15 depth-strata (from 0 to 200 m depth), were alternated along the time series. Strong density gradients and microturbulence (epsilon), related to deep fluorescence layers were determinant for the daylight distribution of zooplankton.

Keywords: Zooplankton , Vertical Profile, Western Mediterranean, Phytoplankton, Hydrography

Introduction

In most of the plankton production models, space is not taken into consideration, as if the pelagic trophic relations took place in an evenly distributed universe. Food or predators are parametrised as average concentration values, although spatial heterogeneity and time variability (patchiness) at all scales is a constant characteristic for marine physical and chemical variables, as well as for plankton communities. The vertical structure of plankton in patches or layers has been described since long [1], but their effects on the coupling between the different trophic components and the oceanographic singularities that control the matter and energy transfer have been poorly studied. In order to allow us to explain some paradoxical features of consumers production under conditions of low average resource availability, in the Framework of the PERFIL-MED cruise we studied the time-changes on the vertical pattern distribution of meso- and microplankton in relation to physical heterogeneities during the summer stratification period.

Study area and methodology

The study took place on board the R/V García del Cid, from the 27/06/09 to the 01/07/09 in the Catalan Sea, NW Mediterranean, at a fixed station (40.45 ºN, 2.39 ºE). Profiles of physical (T, S), chemical (O_2) and biological (fluorescence) data were made with a CTD SBE 911plus. The high-resolution vertical distribution of the rate of turbulent mechanical energy dissipation, epsilon, was obtained with a MST micro-structure profiler®. The vertical distribution of organisms ranging from 50 µm to 2 mm ESR was obtained with a TAPS® (high resolution acoustics, 6 frequency channels from 265 to 3000 KHz). For depth-stratified plankton hauls (15-level, from 0 to 200 m depth) we used a LHPR® fitted with 200 and 50 µm-mesh gauzes, and the on-board analysis of microplankton was made with a FlowCam® on depth-selected water samples. All the profiles were obtained in the 0-200 m depth water column. The analysis of zooplankton biovolume, the organic C_{zoo} contents (from biovolume and a conversion factor, [2]), individual numbers and the identification of taxonomic groups, was made using the free software ZooImage® [3], which uses ImageJ® for the step of image analysis, and R for classification and data analysis.

Results and discusion

A clear deep phytoplankton (fluorescence) layer, accompanied by higher microplankton biomass (data not shown) had developed at the base of the thermocline (Fig. 1 A) , the depth of the peak slightly differing for day and night profiles (52 m night, 58 m day). The same pattern was observed for daylight zooplankton biomass (Biovolume, BV, Fig. 1 C) both directly measured in LHPR samples and that obtained using acoustics (TAPS). Nocturnal zooplankton profiles showed not only higher BV both for LHPR and TAPS, but a shallower peak (vertical migration). The zooplankton LHPR maxima coincided with higher microturbulence (epsilon) values (Fig. 1 B), and during the day with the fluorescence maxima.

The pattern of TAPS profiles was very similar to that of LHPR, although appeared shallower probably due to the effect of internal vawes in the time interval between both samplings. The higher food concentration in the deep fluorescence layer (both phyto and microzooplankton) could explain the coincidence of zooplankton day maxima with the deep fluorescence layer. A better comprehension of the control exerted by physical and biological variables for the vertical heterogeneity of zooplankton biomass would be obtained after a detailed study of the time series for the corresponding variables.

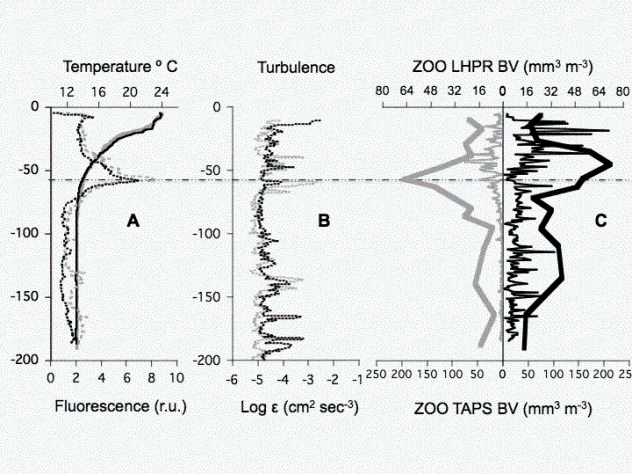


Fig. 1. Examples of two vertical profiles at day (grey lines) and night (black lines) of A: Temperature (ºC) and fluorescence (relative units). B: Microturbulence; C: Zooplankton biovolume (mm^3 m^{-3} from high-resolution acoustics, TAPS (thin lines) and LHPR samples (thick lines). The horizontal dashed line indicates the depth of the fluorescence maximum at day.

References

1 - Alcaraz M., 1985. Vertical distribution of zooplankton biomass during summer strtatification in the Western Mediterranean. *In*: Gibbs P.E. (ed.), Proceedings of the 19th EMBS. Cambridge University Press, Cambridge, pp 135-143.

2 - Alcaraz M., Saiz, E., Calbet A., Trepat I. and Broglio, E. 2003. Estimaating zooplankton biomass through image analysis. *Mar. Biol.* 143: 307-315.

3 - Fernandes J.A., Irigoien X., Boyra G., Lozano J.A. and Albaina A. 2009. Optimizing the number of classes in automated zooplankton classification. *J Plankton Res* 31: 19-29.

TEMPERATURE, SALINITY AND FLOW VARIATIONS IN THE STRAIT OF ISTANBUL (BOSPHORUS)

Husne Altiok [1]*, Halil Ibrahim Sur [1], Ahmet Edip Muftuoglu [1] and Huseyin Yuce [1]
[1] Institute of Marine Sciences and Management, Istanbul University, 34116, Turkey - altiokh@istanbul.edu.tr

Abstract
Monthly temperature and salinity of the upper and lower layers in the Strait of Istanbul are evaluated between February 1996 and February 2009 to obtain long term changes in physical parameters in the strait. The volume fluxes of the layers are also calculated by using monthly ADCP transects data collected in both exits of the strait, from June 1999 to February 2009. Long term variations of temperature, salinity and volume fluxes supplies calculation of the water budget in the strait.
Keywords: Bosphorus, Temperature, Salinity, Water Transport, Time Series

The Strait of Istanbul (Bosphorus) connects the Sea of Marmara and the Black Sea. It has a two-layer exchange flow system. The upper layer with ~18 psu flows from the Black Sea and the lower layer with ~38 psu flows from the Sea of Marmara [1]. The southward barotropic flow in the upper layer and baroclinic flow in the lower layer are separated from each other by a thin interface. The average volume fluxes of the layers (600 $km^3 year^{-1}$ in the upper layer, 300 $km^3/year^{-1}$ in the lower layer) were calculated in terms of the salt and water budget of the Turkish Sea Straits [1, 2].

The data given in this study were collected in the Strait of Istanbul (Figure 1) by R/V ARAR of the Istanbul University, Institute of Marine Science and Management (IMSM-IU).

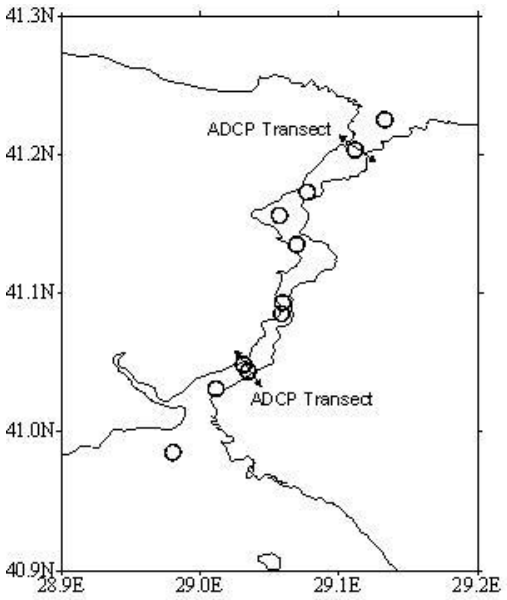


Fig. 1. Stations and ADCP transects locations

Investigation of monthly temperature, salinity and ADCP measurements at the two ends of the strait indicate that these parameters vary in wide range. The temperature changes between 1.9°C in February 1996 and 26.7°C in July 2002 in Black Sea enters. The salinity is in the range of 15.01-18.64 psu.

Our observations indicate that hydraulic control sections agree with a two-layer numerical model [3]. The composite Froude number (G^2) is generally found greater than unity in the southern exit of the strait, in the contraction and in the northern sill. However, current speeds are not high enough to generate hydraulic controls in some situations. For maximal exchange flow two control sections are required in the strait southern exit or the contraction and in the northern sill. We found critical flows at the two ends of the strait at the same time in some months. Usually supercritical flow is observed in only one control section. Especially when the flow is critical in the contraction and southern exit of the strait the lower layer is very thin in the northern section.

The flow exchange is mostly influenced by the hydraulic conditions, the geometry of the strait and rapid changes in the atmospheric conditions [3]. In the strait of Istanbul, the volume fluxes given in Figure 2 vary in an extensive range (upper layer: 5-1051 km^3y^{-1} lower layer: 0.6-866 km^3y^{-1}in the northern exit; upper layer: 0-1216 km^3y^{-1} lower layer: 0-654 km^3y^{-1}in southern exit).

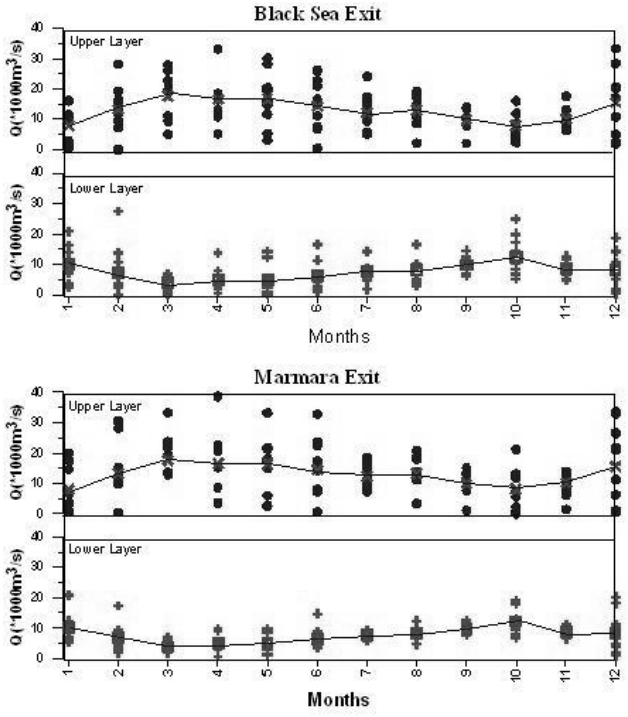


Fig. 2. Monthly volume fluxes

References
1 - Ünlüata Ü., Oguz T., Latif M. and Özsoy E., 1990. On the physical oceanography of the Turkish Straits. *In*: Pratt L.J. (ed.). The physical oceanography of sea straits, Kluwer Academic Publishers, Boston, pp 25-60.
2 - Besiktepe S.T., Sur H.I., Özsoy E., Latif M.A., Oguz T. and Ünlüata Ü., 1994. The circulation and hydrography of the Marmara Sea. *Prog. Oceanogr.*, 34, (4): 285-333.
3 - Oguz T., Özsoy E., Latif M., Sur H.I. and Ünlüata Ü., 1990. Modeling of hydraulically controlled exchange flow in the Bosphorus Strait. *J. Phys. Oceanogr.*, 20: 945-965

IMPLEMENTING A MULTIDISCIPLINARY MONITORING SYSTEM IN THE SPANISH MEDITERRANEAN

T. Amengual [1], A. Aparicio [1], R. Balbín [1], M. Fernández De Puelles [1], M. García-Martínez [2], M. Gaza [1], J. Jansá [1], J. López-Jurado [1]*, A. Morillas [1], F. Moya [2], F. Plaza [3], M. Serra [1], E. Tel [4], M. Vargas-Yáñez [2], L. Vicente [1], P. Zunino [2], M. Alvarez [5] and H. Bange [6]

[1] Instituto Español de Oceanografía, Málaga, Spain
[2] Instituto Español de Oceanografía, Gijón, Spain
[3] Instituto Español de Oceanografía, Baleares, Spain - lopez.jurado@ba.ieo.es
[4] Instituto Español de Oceanografía, Madrid, Spain
[5] IMEDEA (CSIC), Baleares, Spain
[6] IFM-GEOMAR, Kiel, Germany

Abstract

Climate change, resources management or environmental protection are some of the questions that scientists have to deal with in the current century. The management of the marine environment requires multidisciplinary and multitask observing systems which have to consider oceanographic structures, coastal/open sea interactions and those between different basins. This can only be achieved through the international cooperation of national monitoring programs. Here we describe the monitoring system RADMED, implemented in the Spanish Mediterranean by the Instituto Español de Oceanografía. We provide examples of results obtained in the frame of RAMED in such different fields as climate change, distribution of biochemical variables or resources management.

Keywords: Monitoring, Western Mediterranean, Time Series, Hydrology, Plankton

The Instituto Español de Oceanografía carries out four cruises per year covering a large set of oceanographic stations (fig. 1). These stations cover the Spanish Mediterranean and are distributed along transects normal to the coast. The basic strategy is to cover the different areas where differences in the large scale oceanographic conditions could be expected.

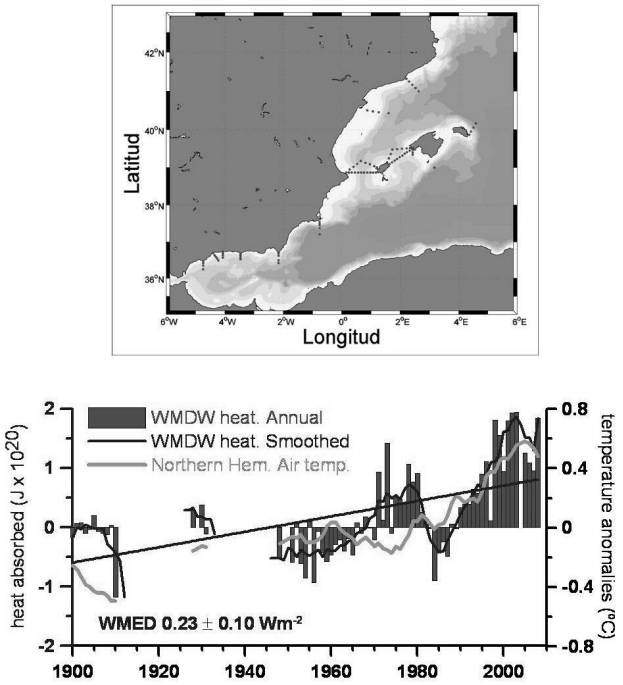


Fig. 1. RADMED and DESMMON stations (upper panel) and time evolution of the WMED heat content along the twentieth century

This monitoring includes productive areas such as the Alboran Sea, oligotrophic waters as those to the north of Cape Palos and around the Balearic Islands, or areas of special interest as those surrounding the Ebro river. Coastal, shelf and deep stations are included. Deep stations provide a description of the water column along the time. The sampling during the four seasons of the year allow us to filter out the seasonal cycle for the purpose of long term climate change studies. At the same time permits the study of some seasonal phenomena such as the intermediate water formation. We can accomplish the description of coastal/open sea and latitudinal gradients in the biochemical distributions of the waters surrounding the Spanish coast. We calculate climatological values for different variables along the Spanish waters, including surface and deep ones. Deviations or anomalies along time can be followed. In all the stations the following sampling is included: Temperature, salinity, dissolved oxygen, chlorophyll-a, inorganic nutrients, phyto and zooplankton abundance and taxonomic composition. At present, other variables of key importance for the analysis of the sea health state are being included. These variables are: pH, Total Inorganic Carbon, nitrous oxide and methane, thanks to the collaboration with IFM-GEOMAR and IMEDEA under the umbrella of DESMMON project.

The objective of this monitoring program is to make an along shore and cross-shore description of the variables mentioned above, defining ranges of variability and mean values. This is possible thanks to the length of time series available, such as temperature (fig.1). Long term changes in temperature, salinity and heat absorbed have been evaluated showing the present warming and salinification of Mediterranean waters in the frame of climate change [1]. The evolution of these time series has many purposes. As an example, it has been shown that monitoring programs can be used in the management of short life cycle species such as *O. vulgaris* (fig. 2) which, in the case of the Alboran Sea, seems to be highly influenced by temperature variability [2]. In the near future we expect to extend the basic description of the health state of the Spanish Mediterranean to gases of greenhouse effect such as carbon dioxide, methane and nitrous oxide.

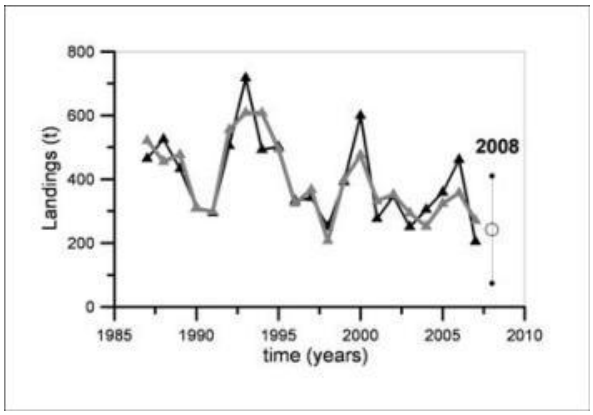


Fig. 2. Octopus landings in the Alboran sea (black line) and landings predicted by a model based on temperature time series

References

1 - Vargas-Yáñez M., Zunino P., Benali A., Delpy M., Pastre F., Moya F., García-Martínez M.C. and Tel E., 2009. How much is the Western Mediterranean really warming and salting. *J. Geophys. Res.*, in press.

2 - Vargas-Yáñez M., Moya F., García-Martínez M.C., Rey J., González M. and Zunino P., 2009. Relationships between *Octopus vulgaris* landings and environmental factors in the northern Alboran Sea (Southwestern Mediterranean). *Fish. Res.*, 99: 159-167.

SORA: A HIGH FREQUENCY FLUX MONITORING STATION AT THE LOWER RHÔNE RIVER

C. Antonelli [1], P. Raimbault [2], V. Boullier [1], M. Arnaud [3], F. Eyrolle [1]* and M. Arnaud [1]

[1] LERCM, Institut de Radioprotection et de Sûreté Nucléaire - Centre de Cadarache, BP 3, 13115 Saint Paul Lez Durance, France - frederique.eyrolle@irsn.fr

[2] Laboratoire de Microbiologie Géochimie et Ecologie Marines UMR 6117 – Centre d'Océanologie de Marseille, case 901, 163 avenue de Luminy, 13288 Marseille Cedex 9, France.

[3] IRSN, Institut de Radioprotection et de Sûreté Nucléaire, Direction de l'Environnement et de l'Intervention, Service d'Etude et de Surveillance de la Radioactivité de l'Environnement, Laboratoire d'Etude Radioécologique en milieux Continental et Mari

Abstract

The Rhône River Observatory Station in Arles (SORA) allow quantifying suspended sediment fluxes to the marine environment as well as liquid and solid fluxes of major nutrients and various natural and artificial radionuclides. This instrumented platform is especially devoted to the survey of flood events through high frequency flux monitoring

Keywords: Sediment Transport, Hydrology, Monitoring, Radionuclides, Rhone Delta

Riverine fluxes towards the marine environment of suspended solids and associated potentially contaminating trace elements (PCTE) represent key environmental data because rivers constitute the main link between continent and ocean in most biogeochemical cycles. This especially concern the Rhône River as its inputs affect primary production significantly in the North-Western Mediterranean area and play a leading role on the marine ecosystem functioning in the whole Gulf of Lions [1]. The importance of floods in annual sediment budgets is now basically known and has been demonstrated in case studies [2-4]. Flood monitoring is nevertheless sensitive as high frequency flux measurements have to be carried out to register such hazardous events [5]. The Rhône River Observatory Station (SORA) was developed by IRSN to register such episodic events. The Station is located at Arles on the right bank of the Grand Rhône River, 3.5 km downstream the diffluence between the Grand Rhône and the Petit Rhône and 45 km upstream the River mouth. The Grand Rhône branch exports to the Sea 85 to 90% of the liquid and solid Rhône river flows. Water is collected at a distance of 7 m from the bank and 0.5 m under the surface whatever the discharge and continuously supplies the Station. High frequency monitoring is displayed into two main modes depending on the liquid flow rate of the River:

- Below 3000 m^3s^{-1}: Daily samplings for TSS and particulate and dissolved nutrients analyses result in 16 sub samples of 150 ml automatically collected each 90 minutes. Radionuclides activities within the dissolved and particulate phases are determined onto monthly integrated samples obtained through sub samples of 15 l automatically collected each hour.
- Above 3000 m^3s^{-1}: Samples for TSS analyses are collected each 4 hours resulting in 8 sub samples of 150 ml taken each 30 minutes. Particle bound radionuclides are measured onto samples taken each 8 hours through 24 sub samples of 5l automatically collected each 20 minutes.

The threshold flow rate of 3000 $m^3 s^{-1}$ was chosen on the basis of previous studies: [6] observed a breakdown in the relation between liquid flow and TSS concentrations corresponding to the beginning of the sediment transport under flood condition. These observations were confirmed by [7] that furthermore observed higher TSS concentrations with depth. Samples for TSS analysis are poisoned with $HgCl_2$ and conserved at 5°C until they are filtrated on 1µm pre conditioned glass fiber filters (dried at 450°C for one hour). Uncertainty on TSS concentrations is estimated to 5 10^{-4} $g.l^{-1}$. Daily and hourly liquid discharges in Arles are made available by the CNR (Compagnie Nationale du Rhône). These data allow quantifying liquid and solid fluxes associated with each sampling periods and especially with flood events.

Acknowledgements

The SORA Station received the support of "Agence de l'eau Rhône-Méditérranée-Corse", the French National Research Agency (ANR) through the ANR-EXTREMA project (ANR-06-VULN-005, 2007-2010) and from the competitive poles "Mer PACA (Provence Alpes Côte d'Azur)" and "Gestion des Risques et Vulnérabilité des territoires". Additional funding supports are delivered by ORME program (Observatoire Régional Méditerranéen de l'Environnement). Liquid discharges values in Arles were made available thanks to the CNR (Compagnie Nationale du Rhône).

References

1 - Raimbault P., Durrieu de Madron X., 2003. Research activities in the Gulf of Lion (NW Mediterranean) within the 1997-2001 PNEC project. *Oceanol. Acta*, 26: 291-299.

2 - Rolland B., Antonelli C. and Eyrolle F., 2004. Fluxes of suspended material and associated radionuclides to the sea during flood events of the Rhône River. *In:* Proceedings of the ECORAD 2004 international symposium, 6-10 sept. 2004, Aix en Provence, France, P3: 35.

3 - Radakovitch O., Roussiez V., Ollivier P., Ludwig W., Grenz C. and Probst J.L., 2007. Input of particulate heavy metals from rivers and associated sedimentary deposits on the Gulf of Lion continental shelf. *Estuar. Coast. Shelf S.*, 77, 2: 285-295.

4 - Antonelli C., Eyrolle F., Rolland B., Provansal M. and Sabatier F., 2008. Suspended sediment and 137Cs fluxes during the exceptional December 2003 flood in the Rhone River, southeast France. *Geomorphology*, 95, 3-4: 350-360.

5 - Moatar F. and Meybeck M., 2007. Riverine fluxes of pollutants: Towards predictions of uncertainties by flux duration indicators. *Comptes Rendus Geosciences*, 339, 6: 367-382.

6 - Pont D., Simonnet J.P. and Walter A.V., 2002. Medium-term changes in suspended sediment delivery to the ocean : consequences of catchment heterogeneity and river management (Rhône River, France). *Estuar. Coast. Shelf S.*, 54: 1-18.

7 - Antonelli C. 2002. Flux sédimentaires et morphogenèse récente dans le chenal du Rhône aval. PhD thesis, Université Aix-Marseille I, 272 p.

LTER, LONG TERM ECOLOGICAL RESEARCH ALONG THE ITALIAN COASTS

M. Bastianini [1]*, M. Buia [2], B. Cataletto [3], S. Fonda Umani [4], A. Lugliè [5], M. Marini [1], B. Padedda [5], P. Povero [6], A. Pugnetti [1], F. Raicich [1], M. Ravaioli [1] and A. Zingone [2]

[1] CNR - Istituto di Scienze Marine (ISMAR) Bologna, Venezia, Trieste, Ancona, Italia - mauro.bastianini@ismar.cnr.it

[2] Stazione Zoologica A. Dohrn, Napoli, Italia

[3] OGS Dip. Oceanografia Biologica (BiO), Trieste, Italia

[4] Università di Trieste, Dip. di Scienze della Vita, Trieste, Italia

[5] Università degli Studi di Sassari, Dip. di Scienze Botaniche, Ecologiche e Geologiche (DSBEG), Sassari, Italia

[6] Università degli Studi di Genova, Dip. per lo Studio del Territorio e delle sue Risorse (DIP.TE.RIS.), Genova, Italia

Abstract

Long-term ecological research (LTER) plays a crucial role in tracing and predicting ecosystem trends in response to environmental changes. Within the LTER-Italy network, which is part of the International LTER network, a great scientific effort is concentrated on the marine environment. To this end several different Italian institutions, working in four coastal sites, are networked with the aim of sharing methodologies, experimental approaches, and ecological data. This intellectual and experimental partnership among disciplines and researchers represents an essential requirement also for knowledge driven environmental policy.

Keywords: Time Series, Plankton, Biodiversity, Coastal Systems

Long-term ecological research (LTER) is fundamental to assess the main trends of marine ecosystems and relate them to variations in climate and anthropogenic impact at the interannual and decadal scales. LTER is also essential for testing ecological theories, enhancing our capacity for short- and medium-term forecasting and the managing of the environmental resources. The LTER-Italy network, which is part of the European (www.lter-europe.net) and international LTER (www.ilternet.edu) ones, presently includes 20 sites, 4 of which are marine (Fig. 1): the Northern Adriatic Sea, the Gulf of Naples, the Sardinian coastal waters and the Portofino Marine Protected Area.

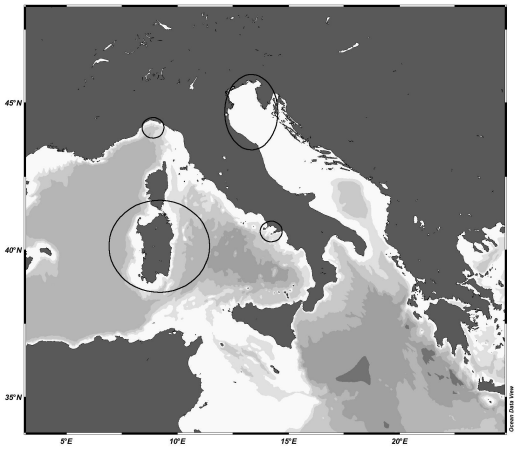


Fig. 1. Marine sites in the LTER-Italy network

Intensive monitoring programmes and interdisciplinary experimentation at these sites are carried on at six Italian scientific institutions. The main common ecological investigations concern: i) patterns and trends in plankton and benthos communities, ii) carbon pathways and budgets in the pelagic food web, iii) trophic state and biodiversity variations, in relation to local and global changes. Relevant examples of results of these activities concern mainly the detection of interannual changes in plankton patterns and scales of variability as well as significant shifts [1, 2, 3] (Fig 2). In some key areas advanced automatic acquiring systems are operating, as early warning systems for dystrophic events and a validating centre for numerical models. An intense effort has been done to disseminate this kind of information among different stakeholders. For a couple of examples see: www.ve.ismar.cnr.it/piattaforma/, s1.bo.ismar.cnr.it. and portofino.macisteweb.com/.

While the research carried so far has been based on efforts of individual institutions, it is predictable that the LTER network will help generating and sharing ideas, protocols, data sets and research facilities, in order to address and answer research questions on important environmental topics in a coordinated way, giving also a scientifically sound support to environmental management.

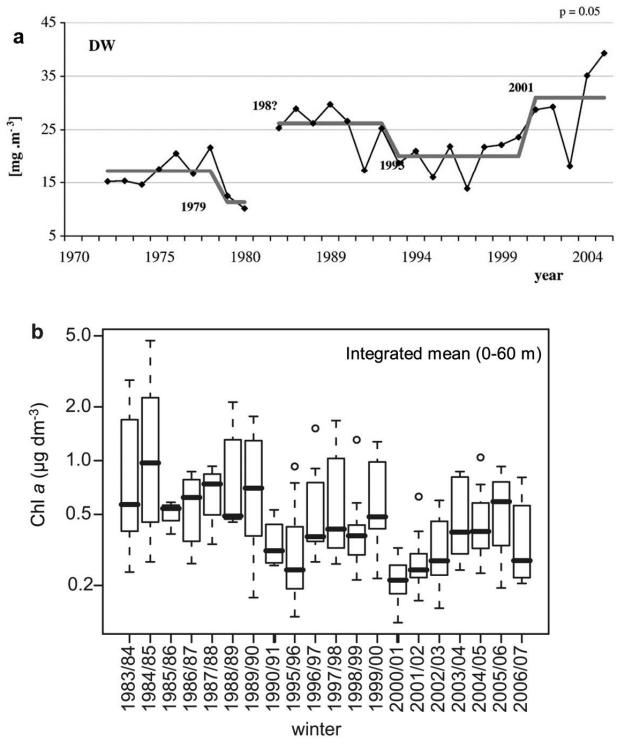


Fig. 2. a) Northern Adriatic: shifts in zooplankton biomass related to temperature variations (modified from [1]) b) Gulf of Naples: Clorophyll a decrase during last two decades winters (modified from [3])

References

1 - Conversi A., Peluso T. and Fonda-Umani S., 2009. The Gulf of Trieste: a changing ecosystem. *J Geophys Res, Oceans* 114 C03S90 (doi:10.1029/2008JC004763)

2 - Mozetic P., Solidoro C., Cossarini G., Socal G., Precali R., Francé J., Bianchi F., Smodlaka N., De Vittor C. and Fonda Umani S., 2009. Recent trends towards oligotrophication of the northern Adriatic: evidence from chlorophyll a time series. *Estuaries and Coasts*. (DOI 10.1007/s12237-009-9191)

3 - Zingone A., Dubroca L., Iudicone D., Margiotta F., Corato F., Ribera d'Alcalà M., Saggiomo V. and Sarno D., 2009. Coastal Phytoplankton Do Not Rest in Winter. *Estuaries and Coasts* DOI 10.1007/s12237-009-9157-9.

AQUA ALTA – THE OCEANOGRAPHIC TOWER OF ISMAR-CNR AFTER ALMOST 40 YEARS OF ACTIVITY

Mauro Bastianini [1]*

[1] Institute of Marine Sciences - CNR, Venice, Italy - mauro.bastianini@ismar.cnr.it

Abstract

The oceanographic tower "*Aqua Alta*" of the Institute of Marine Sciences of CNR is located in the Northern Adriatic Sea, 15 km offshore the Venice lagoon on 15 m of depth. The tower, operational since the early '70s, hosts a very large variety of instruments, meteorological, oceanographic, physical and chemical. Some of the time series collected on board are among the longest ones in the world. The tower allows both long term automatic instruments deployment, connected in real time with the land station, and extended periods for people on board for devoted campaigns. Multiple power sources, also controlled from land, are available. Measurements done during one of the worst historical storms has led to the evidence of one of the key processes controlling the tidal level in the lagoon in Venice in cases of serious floods.

Keywords: Adriatic Sea, Monitoring, Time Series

The oceanographic tower "Aqua Alta" of ISMAR-CNR (see Figure 1) is located 15 km offshore the coast of the Venice lagoon, in the Northern Adriatic Sea, on 16 metre of depth. It is the only fixed marine scientific structure in Italy, and one of the very few in Europe, that allows people on board for prolonged periods for intensive campaigns in the middle of the sea. The capability of having a structure in the open sea, large enough to withstand the worst storms, but small enough not to interfere, as with the large oil or gas platforms, with the surrounding environment allows highly accurate and hard to get measurements also in heavy difficult conditions.



Fig. 1. The oceanographic tower "Aqua Alta".

The tower has three floors plus the terrace at 12 metre height above the mean sea level. The structure is composed of four 60 cm diameter vertical poles, a few metres apart, connected at four different levels by multiple smaller poles. The tower is fully self-sufficient for what energy is concerned, powered by two diesel power generators complemented by a very large set of batteries plus solar and wind generators. "Aqua Alta" is fully equipped with a very large set of instruments, devoted to meteorological, oceanographic and chemical parameters. Measurements go back to the early '70s, so that some time series provide sufficient information to consider climate changes. The abundant, sometime too much, submarine life has provided ample material for biological researches. Most of the instruments are devoted to long term measurements. However, a substantial part of the use of the tower concerns specific campaigns carried out for prolonged periods with people on board. Cavaleri provided in 1999 an extensive review of the researches on board till that year [1].

The wind and wave data available from board have provided essential information for the design of the barrages, presently under construction, that will save the Venice lagoon from the worst floods. The floods are associated to the sirocco storms.

An extremely intense one, the strongest in memory after the catastrophic 1966 one, happened in December 1979. Heavy damage was caused on board, with the second floor completely destroyed. Notwithstanding the lack of power, two mechanical instruments, an anemometer and a mareograph, provided essential data. In particular the latter provided the first evidence in the world of coastal set-up, the accumulation of water, with the consequent local sea level raising, that takes place as a consequence of wave breaking toward the coast.

This finding, properly modelled [2], is now integral part of the local tidal forecast system. Recently a substantial upgrading has been done on the tower, with the introduction of extensive remote control and data handling in real time. A new tide-wave recording system is in operation at 50 m distance from the tower, with direct connection, together with meteorological data, to the display in ISMAR. Some webcams have been installed for direct visualisation of the meteo-oceanographic situation and control of the area. An advanced experiment has just started with an automatic system, controlled from land, capable to obtain at high rate continuous 3-dimensional measurements of the sea surface under storm conditions.

References

1 - Cavaleri L., 1999. The oceanographic tower Acqua Alta: more than a quarter of a century of activity. *Nuovo Cimento*, 22C (1): 1-111.

2 - Bertotti L., and Cavaleri L., 1985. Coastal set-up and wave breaking, *Oceanol. Acta*, 8 (2): 237-242.

CIRCULATION VARIABILITY IN THE ADRIATIC SEA AND IN SMALL DOMAINS ALONG THE EASTERN ADRIATIC COAST DURING 2007 AND 2008

G. Beg Paklar [1]*, I. Janekovic [2], M. Dutour Sikiric [2], I. Vilibic [1], V. Dadic [1] and B. Grbec [1]
[1] Institute of Oceanography and Fisheries, Split, Croatia - beg@izor.hr
[2] Rudjer Boskovic Institute, Zagreb, Croatia

Abstract
POM and ROMS ocean models were used to perform a year-long simulation of the Adriatic circulation. Both models had almost the same setup which allowed for a reliable comparison between their results. Although these models successfully reproduced the basic characteristics of the Adriatic circulation, some differences appeared and they could be related to the different numerical formulation of two models. Model results were evaluated with the CTD and HF radar measurements. Simulated fields from both Adriatic models were used for the open boundary conditions in several coastal domains along the eastern coast through a nesting procedure. The impact of the selected open boundary conditions on the circulation and thermohaline properties in the coastal domains was assessed with ADCP and CTD measurements.
Keywords: Adriatic Sea, Circulation, Circulation Models, Coastal Models, Air-Sea Interactions

Current variability in the Adriatic Sea from November 2007 to October 2008 has been simulated with two three-dimensional nonlinear sigma models: Princeton Ocean Model (POM) [1] and Regional Ocean Modeling System (ROMS) [2]. In a year-long simulation both numerical models were forced with atmospheric, river and tidal forcing. Atmospheric forcing for the ocean models was calculated from the output fields of the meteorological mesoscale model ALADIN [3] having 8 km horizontal resolution and 3 hour resolution in time. A tidal function was applied on the southern open boundaries of both models for denivelation and transport, while the radiation condition was applied for the three-dimensional current field. The ocean models had horizontal resolution of approximately 2 km while along the vertical 22 and 30 sigma layers were defined for POM and ROMS respectively.

Surface mean monthly current fields obtained by the POM model show significant resemblance with the corresponding fields from the ROMS. Although considerable variability can be observed in the modelled current fields, they also indicate some common features in accordance with well-known characteristics of the Adriatic scale circulation. The general circulation is cyclonic with several imbedded, mostly cyclonic, gyres. Two cyclonic gyres are around the main pits – South Adriatic and Jabuka Pit, and one can be observed in the northernmost part of the Adriatic. Current fields in the winter period resemble bora induced current fields [4], indicating the bora wind as an important driving mechanism for the Adriatic general circulation. Current intensities during summer decreased and numerous small-scale eddies appeared. A South Adriatic cyclonic gyre over the deepest Adriatic area is present in all monthly current fields but with variable intensities. A cyclonic gyre above the South Adriatic Pit is a well-known characteristic of the Adriatic circulation and it is supposed to be topographically controlled by the South Adriatic Pit and Palagruža Sill.

The main difference between POM and ROMS monthly averaged current fields is manifested through the current velocity intensities, mainly in jet currents that are attached to the outer boundary of the Croatian outer islands, as well as through the intensities of the cyclonic South Adriatic gyre. The evaluation of the modelled fields was based on the thermohaline measurements along the Split-Mt Gargano transect and HF radar measurements in the northern Adriatic.

The results obtained from both Adriatic-scale models were used to define open boundary conditions for the coastal shelf model embedded along the eastern coast using one-way offline nesting procedure. The horizontal resolution of the shelf model was approximately 1 km. Furthermore, two local models with resolution of 200 m were nested in the coastal shelf model by using the same methodology. The evaluation of the modelled fields in the coastal area, as well as the assessment of their sensitivity to the choice of the open boundary conditions was made through CTD and ADCP measurements via RMS errors and correlation coefficients.

References

1 - Blumberg A.F. and Mellor G.L., 1987. A description of a three-dimensional coastal ocean circulation model. *In*: Three Dimensional Coastal Ocean Models, edited by N. S. Heaps, *Coastal and Estuarine Science* 4, AGU, Washington, D.C., 1-16 pp.
2 - Haidvogel D.B., Arango H., Hedström K., Beckmann A., Rizzoli P. and Shchepetkin, A., 2000. Model evaluation experiment in the North Atlantic Basin: simulations in nonlinear terrain-following coordinates. *Dyn. Atmos. Ocean* 32: 239-281.
3 - Cordoneanu E. and Geleyn J.-F., 1998. Application to local circulation above the Carpathian-Black Sea area of a NWP-type meso-scale mode, *Contr. Atmos. Phys.*, 71: 191-212.
4 - Beg Paklar G., Isakov V., Koracin D., Kourafalou V. and Orlic M., 2001. A case study of bora-driven flow and density changes on the Adriatic shelf (January 1987), *Cont. Shelf Res.*, 21: 1751-1783.

PROCESS STUDY SIMULATIONS OF THE DENSE SHELF WATER CASCADING INTO THE CAP DE CREUS CANYON

A. Bergamasco [1]*, K. Schroeder [2], P. Puig [3], S. Carniel [1] and M. Sclavo [1]
[1] Istituto di Scienze Marine CNR ISMAR, Venice, Italy - andrea.bergamasco@ismar.cnr.it
[2] CNR-ISMAR, La Spezia, Italy
[3] Institut de Ciències del Mar, CSIC, Barcelona, Spain

Abstract
Intense dense shelf water cascading events occurred in the North-Western Mediterranean Sea in early 2005. These events have contributed to the basin-wide spreading of a deep thermohaline and turbid anomaly, which has been extensively observed by many authors. The major volume of dense shelf water formed on the Gulf of Lions shelf is exported through the Cap de Creus Canyon, at the western edge of the gulf. The intensity of the 2005 events gives the chance to perform numerical process study simulations of the down-canyon dense water flow. The Regional Ocean Modeling System (ROMS) is used to study the dense plume cascading dynamics, first using an idealized but realistic canyon topography and then the multibeam derived bathymetry.
Keywords: Gulf Of Lions, Western Mediterranean, Models

The Gulf of Lions is one of the regions in the Mediterranean where dense water formation occurs by open-sea convection process as well as by dense shelf water cascading when coastal surface waters over the wide shelf become denser than the underlying water masses and cascade downslope until reaching their equilibrium depth [1]. Dense shelf water cascading is one of the main processes of shelf-ocean basin exchanges, enhanced by the presence of submarine canyons that deeply cut the continental shelf-edge and slope.

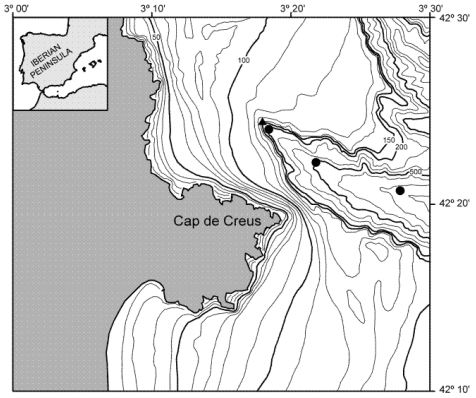


Fig. 1. Bathymetric map of the southwestern end of the Gulf of Lions showing the location of the Cap de Creus Canyon. Symbols represent the location of near-bottom instruments deployed along the canyon axis, at 145 m depth (tripod) and at 200, 500 and 750 m depth (moorings).

The occurrence and characteristics of dense shelf water cascades from the Gulf of Lions have been continuously monitored at the Cap de Creus submarine canyon head (between 145 m and 750 m depth), in terms of near-bottom current velocities, temperature, salinity and turbidity (Fig. 1).

The Regional Ocean Modeling System (ROMS), a free-surface, hydrostatic, primitive equations, general circulation ocean model, that uses stretched, terrain-following coordinates in the vertical and orthogonal curvilinear coordinates in the horizontal was setup with an idealized and a realistic bottom topography. The horizontal resolution was variable increasing from 500 m up to 100 m across the canyon axis (y direction of the model) to better describe the steep topography. Along the canyon (x direction of the model) the resolution was 500 m, while in vertical 40 levels were used, with higher resolution in the bottom boundary layer.

Different sets of numerical experiments have been done to explore how the downslope flow develops into a gravity current cascading event, and the time scales characteristics of such events.

Since the objective of the work was a process study, the background thermohaline field has been defined using the MEDAR winter climatology and the characteristics of the simulated plume from the mooring data available along the canyon. According to [2] and [3] the Cap de Creus Canyon is the main pathway for dense shelf water cascading, due to its strategic position at the point where the cyclonic circulation of the dense water formed in the Gulf converges. Dense waters preferentially enter the Cap de Creus Canyon across the southern canyon wall due to the coastal constrain, showing a pulsating nature with a periodicity of 3–6 days, presumably associated with the cross-slope fluctuation of a topographic wave [4]. For this reason, the model was setup with the plume entering the domain at its southwestern edge.

In order to compare model results with available data, the tripod and mooring mooring measurements (Fig. 1) were analyzed, focusing only on the beginning of the 2005 cascading event. In particular we chose the first plume, detected at the deepest mooring, from February 3rd to 8th 2005 (Fig. 2). Despite this event being constituted by a succession of 8-9 smaller impulses, each of them lasting less than 1 day (Fig. 2), its time scale resulted to be particularly suitable for being modelled with a process study approach, focusing on the dynamics of a "single" plume, instead of the dense water cascading during the whole winter.

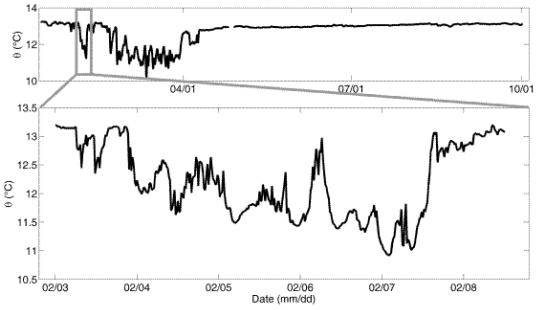


Fig. 2. Temporal evolution of potential temperature, recorded by the 750 m depth mooring, during the selected plume event extracted from the whole record.

This study could be the framework of a model-based experimental design, since the numerical results can provide helpful information about the most suitable locations of continuously measuring instruments along the canyon, increasing the probability to detect the main flow of the descending plume.

References
1 - CIESM, 2009. Dynamics of Mediterranean deep waters. N° 38 in CIESM Workshop Monographs [F. Briand, Ed.], 132 pages, Monaco.
2 - Ulses C., Estournel C., Puig P., Durrieu de Madron X. and Marsaleix P., 2008. Dense shelf water cascading in the northwestern Mediterranean during the cold winter 2005: Quantification of the export through the Gulf of Lion and the Catalan margin, *Geophys. Res. Lett.*, 35, L07610.
3 - Dufau-Julliand C., Marsaleix P., Petrenko A. and Dekeyser I., 2004. Three-dimensional modeling of the Gulf of Lion's hydrodynamics (northwest Mediterranean) during January 1999 (MOOGLI3 Experiment) and late winter 1999: Western Mediterranean Intermediate Water's (WIW's) formation and its cascading over the shelf break, *J. Geophys. Res.*, 109, C11002.
4 - Puig P., Palanques A., Orange D.L., Lastras G. and Canals M., 2008. Dense shelf water cascades and sedimentary furrow formation in the Cap de Creus Canyon, northwestern Mediterranean Sea. *Cont. Shelf Res.*, 28: 2017-2030.

STRUCTURE HYDRODYNAMIQUE ET VARIATION DE LA CHLOROPHYLLE A AU NIVEAU D UN TRANSECT DANS LE DETROIT DE GIBRALTAR

Amina Berraho [1]*, Omar Ettahiri [1], Ahmed Makaoui [1] and Abdellatif Orbi [1]
[1] Institut National de Recherche Halieutique, 20000, Casablanca, Morocco - amina_berraho@yahoo.fr

Abstract
Les paramètres hydrologiques (température, salinité, sels nutritifs) et biologique (chlorophylle 'a') ont été étudiés au niveau d'un transect vertical dans le détroit de Gibraltar (radiale Camarinal) en 2006 et 2007. Les diagrammes T/S et les profils CTD montrent l'existence de deux masses d'eau : l'une superficielle d'origine atlantique, chaude et moins salée et l'autre profonde, froide et plus salée, d'origine méditerranéenne. La variation de la teneur en chlorophylle 'a' est moins accentuée le long de la colonne, par contre elle diffère d'une période à l'autre, avec une faible richesse en période froide (décembre).
Keywords: Chlorophyll-a, Strait Of Gibraltar, Temperature, Salinity, Nutrients

Introduction
Le détroit de Gibraltar est le siège d'une circulation complexe caractérisée par l'existence de deux systèmes de masses d'eau : l'eau atlantique entrant en surface de direction est et l'eau méditerranéenne sortant en profondeur de direction ouest [1] et dont le débit moyen d'échange à travers le détroit est estimé à 0,7 Sv [2]. La couche d'interface AMI (Atlantic-Mediterranean Interface), a une épaisseur significative, caractérisée par une halocline bien marquée, définie à 37 psu avec des valeurs plus élevées vers l'est [2], [3]. A ce niveau, l'abondance de la chlorophylle et du microplancton, a tendance à augmenter du sud-ouest au nord-est et coïncide avec l'élévation graduel de la profondeur de l'interface dans la même direction [4].

Matériel et Méthodes
Le transect étudié est situé sur la longitude 05°45'W et comporte 5 stations entre 35°52,7 et 35°58,5N. Les périodes d'étude correspondent à mars, mai, décembre 2006 et mai, juillet, novembre 2007. La température et la salinité ont été mesurées par la CTD et les échantillons d'eau ont été prélevés selon un dispositif de bouteilles associé à la CTD. Le dosage de l'oxygène dissous a été réalisé par la méthode de Winkler, les sels nutritifs par spectrophotométrie et la chlorophylle 'a' par fluorimètrie (Turner Desings-10 AU).

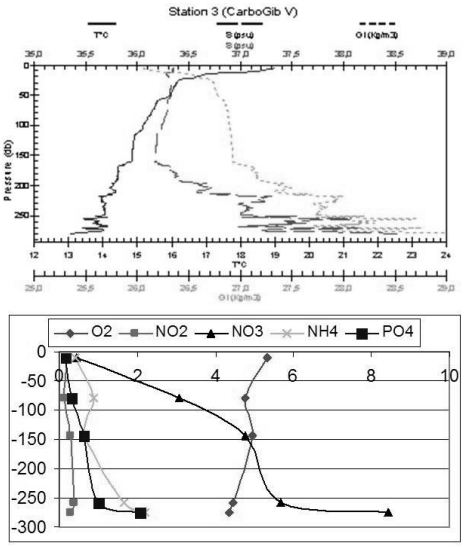


Fig. 1. Profils de CTD, d'oxygène dissous et des nutriments au niveau de la station 3

Résultats et Discussion
Les diagrammes T-S et les profils des paramètres physiques (CTD), montrent l'existence de deux masses d'eau, séparées par une interface d'épaisseur variable (40 à 50 m) et dont la position est variable (100 m à 160 m) selon la profondeur maximale de la station. Cette zone est marquée par une halocline très nette surtout au niveau de la station 3, située dans le chenal principal. Ainsi, en surface, l'eau atlantique est caractérisée par une salinité moyenne de 36,3 psu et une température variable en fonction de la saison (>15°C) ; alors que l'eau méditerranéenne plus salée (> 38 psu) et froide (< 13,5°C) est située au delà d'une profondeur de 200 m (station 3). La variation des nutriments le long de la section Camarinal montre une richesse qui suit l'apparition de l'eau méditerranéenne marquée par une nitracline importante à partir de l'interface jusqu'au fond (Figure 1, cas de la station 3). La zone d'étude se caractérise également par la présence d'ondes internes qui peuvent modifier le profil des paramètres hydrologiques le long de la colonne d'eau, (cas de la station 3, mai 2006). Ces ondes internes sont générées près du chenal Camarinal [5].
La distribution de la chlorophylle 'a' est peu variable le long de la colonne d'eau et les concentrations sont faibles (< 0,5 µg/l). Généralement, l'eau atlantique est relativement plus riche en chlorophylle 'a' que l'eau méditerranéenne profonde, malgré sa forte richesse en nutriments. Dans les couches sub-superficielles, les conditions en lumière sont optimales mais limitées en éléments nutritifs, alors que la situation est inverse au fond. Le suivi temporel de la teneur en chlorophylle 'a' au niveau de la station 3, montre des valeurs très faibles le long de la colonne d'eau, enregistrées en décembre, en relation avec la variation saisonnière. Le maximum (0,47µg/l) est observé en mai, à 80 m de profondeur, associé à la thermocline (Figure 2). Le développement et l'importance du maximum de chlorophylle (DCM = Deep Chlorophyl Maxima) sont inversement liés à la distance entre l'AMI et la thermocline [4]. Cette position est décisive, car la vitesse à proximité de l'interface est faible ce qui permet une accumulation préférentielle des cellules phytoplanctoniques à ce niveau [4].

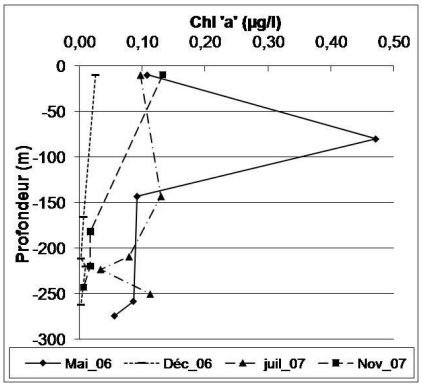


Fig. 2. Distribution de la chlorophylle 'a' au niveau de la station 3

References
1 - Lacombe H. and Richez C., 1982. The régime of the Strait of Gibraltar. *In*: Nihoul J.C.J. (ed.), Hydrodynamics of Semi-Enclosed Seas. Elsevier, Amsterdam, pp 13-73.
2 - Bryden H.L., Candela J. and Kinder T.H., 1994. Exchange through the Strait of Gibraltar. *Prog. Oceanogr*., 33: 201-248.
3 - Bray N.A., Ochoa J. and Kinder T.H., 1995. The role of the interface in exchange through the Strait of Gibraltar. *J. Geophys. Res*., 100: 10755-10776.
4 - Gomez F., Echevarria F., Garcia C.M., Prieto L., Ruiz J., Reul A., Jimenez-Gomez F. and Varela M., 2000. Microplankton distribution in the Strait of Gibraltar: coupling between organisms and hydrodynamic structures. *J. Plank. Res*., 22 (4): 603-617.
5 - Armi L. and Farmer D.M., 1988. The flow of Mediterranean Water through the Strait of Gibraltar. *Prog. Oceanogr*., 21: 1-105.

WIND WAVE FORECAST IN THE ADRIATIC SEA – A TOOL FOR BETTER TIDAL FORECAST IN THE NORTHERN ADRIATIC SEA

Luciana Bertotti [1]*, Paolo Canestrelli [2], Luigi Cavaleri [1] and Franca Pastore [2]
[1] Institute of Marine Sciences, Venice, Italy - luciana.bertotti@ismar.cnr.it
[2] Istituzione Centro Previsioni e Segnalazioni Maree, Venice, Italy

Abstract
The present tidal forecast system in Venice has been operational for more than 20 years. The present average accuracy is of better than ten cm for forecasts up to 6-hours.. In highly severe storms wind waves contribute substantially to the tide level in the Venice lagoon via the set-up effect. Therefore ISMAR and IPSM are jointly managing an operational wave forecast system for the Adriatic Sea. The driving is given by the surface winds produced by ECMWF as input to the WAM wave model with 1/12 degree resolution. The results are validated using the data collected at the ISMAR oceanographic tower, 15 km offsahore the Venice lagoon
Keywords: Models, Adriatic Sea

The area of interest
Large scale wave modelling are openly available. For instance, the European Centre for Medium-Range Weather Forecasts (ECMWF, Reading, U.K.) provides ten day forecast worldwide. However, these large models, while very accurate in the open oceans, fail to provide comparably accurate results in the inner seas, like the Mediterranean or, at greater extent, the Adriatic Sea. This led to the development of systems as NETTUNO, a combined product of the Italian National Meteorological Service and ISMAR, and HENETUS, here described, a system devoted to the Adriatic Sea [1] with the aim, among others, of improving the tidal forecast in the Northern Adriatic Sea. The grid used for our purposes has 1/12 degree resolution. A higher resolution can be used in front of the Venice lagoon to take into proper account the coastal effects of breaking waves (see
below).

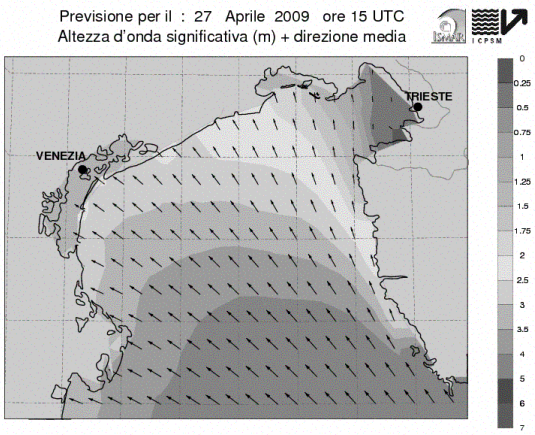


Fig. 1. Wave field forecast in the Northern Adriatic Sea

Input information
The input to the model is the daily forecast provided by ECMWF. However, the ECMWF winds on the Adriatic are strongly underestimated. Therefore, before passing them to the wave model, the wind speeds are corrected with an objective procedure based on long term comparison between the ECMWF winds and the extensive data available from the QuikSCAT scatterometer [2].

Modelling
The WAM wave model [3] is used for the daily application. WAM has been the first advanced, so-called third-generation wave model.. The ECMWF wind data are daily received by ICPSM and passed to ISMAR. The wave results are available early in the day and transferred immediately to ICPSM. Tidal forecast by ICPSM has been operational for more than 20 years with ever increasing accuracy, presently between 5 and 10 cm at 6-hour distance . However, to avoid an underestimate during the most severe sirocco storms associated to set-up, wave effect on coastal sea level needs to be taken into account..

Model results
The output of the model is available both as numbers and graphics. The graphical output for the most northerly part of the Adriatic Sea is shown in Figure 1. It represents a strong event of sirocco happened in April 2009. The use of shading plus the arrow pointing to wave height and direction provides a clear and intuitive representation of the situation. These maps are available at 3-hour intervals for the next 72 hours. These forecasts in front of the Venice coastline are verified by comparison with the data recorded at the ISMAR oceanographic tower. The statistics is shown in Figure 2, showing the results for the later analysis (AN) and for the forecasts at 1 (F1), 2 (F2) and 3 (F3) day distance. The comparison shows clearly the high quality of the forecasts, more than enough for any practical use.

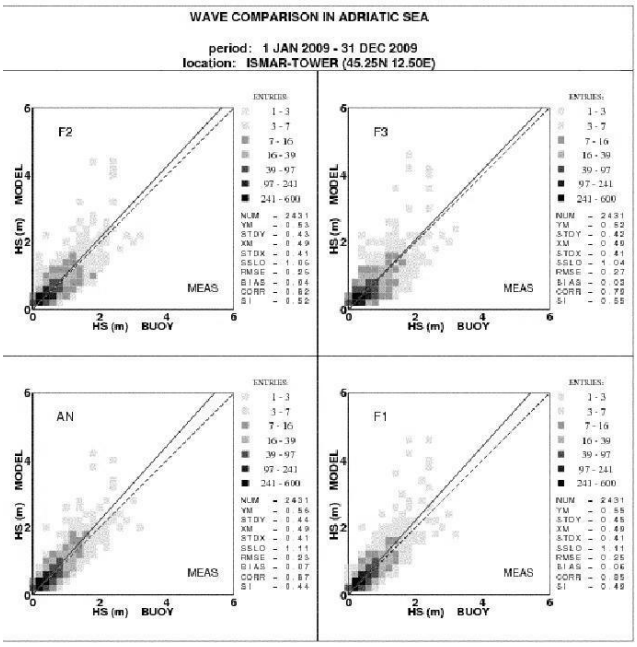


Fig. 2. Comparison between analysis and forecast wave heights versus the measured values on the "Aqua Alta" ISMAR oceanographic tower.

References
1 - Bertotti L. and Cavaleri L., 2009. Wind and wave prediction in the Adriatic Sea, *J.Mar.Sc.*(available online).
2 - Cavaleri L and Bertotti L., 1997, In search of the correct wind and wave fields in a minor basin, *Mont.Weat.Rev*, 125, 8, 1964-1975.
3 - Komen G.J, Cavaleri L., Donelan M., Hasselmann K., Hasselmann S. and Janssen P.A.E.M., 1994. Dynamics and Modelling of Ocean Waves, Cambridge Univ. Press, 532pp.

MODELLING THE MEDITERRANEAN SEA INTERANNUAL VARIABILITY OVER 1961-2000: FOCUS ON THE EASTERN MEDITERRANEAN TRANSIENT (EMT)

J. Beuvier [1]*, F. Sevault [2], M. Herrmann [2], H. Kontoyiannis [3], W. Ludwig [4], M. Rixen [5], E. Stanev [6], K. Béranger [1] and S. Somot [2]

[1] Unité de Mécanique, Ecole Nationale Supérieure de Techniques Avancées ParisTech (ENSTA-ParisTech/UME), Palaiseau, France - jonathan.beuvier@ensta.fr

[2] Centre National de Recherches Météorologiques (CNRM), Météo-France, Toulouse, France

[3] Hellenic Center for Marine Research (HCMR), Athens, Greece

[4] Centre de Formation et de Recherche sur l'Environnement Marin (CEFREM), Perpignan, France

[5] NATO Undersea Research Center (NURC), La Spezia, Italy

[6] Institute for Coastal Reasearch (ICR), GKSS Research Center, Geesthacht, Germany

Abstract

We study the climate variability of the Mediterranean Sea and the Eastern Mediterranean Transient by carrying out a simulation over 1961-2000 with a Mediterranean OGCM driven by realistic interannual high-resolution air-sea fluxes. Interannual databases for Atlantic T-S characteristics and rivers and Black Sea runoff are used. The sequence of the EMT events is well reproduced: the high winter oceanic surface cooling and drought over the Aegean Sea in the early 1990's, the high amount of dense Cretan Deep Water formed during these winters and the overflow and the spreading of this CDW in the eastern Mediterranean.

Keywords: Eastern Mediterranean, Water Convection, Circulation Models, Aegean Sea, Air-Sea Interactions

In this work, we study the Mediterranean interannual variability and in particular the Eastern Mediterranean Transient, by using NEMOMED8, an eddy-permitting Mediterranean OGCM at 1/8° of resolution (about 10 km), regional version of the NEMO model. A realistic hindcast is performed from 1961 to 2000, forcing the model with daily atmospheric fluxes produced with ARPERA, a dynamical downscaling of the ERA40 reanalyses (resolution of about 50 km). Interannual datasets are used to represent the hydrological fluxes of the river runoff [1], the Black Sea discharge [2] and the Atlantic Water characteristics [3], in addition to the freshwater flux from the atmosphere.

Considering heat and salt contents at basin-scale, the simulation show a good agreement when comparing to an interannual gridded database based on observations [4]. This simulation is able to reproduce the sequence of the EMT events in very good agreement with the observations [5]:

- the strong heat and water losses at the surface of the Aegean Sea observed during the winters 1991-92 and 1992-93 (respectively -73 W/m^2 and -2.0 mm/day in NDJF 1991-92, -65 W/m^2 and -2.8 mm/day in NDJF 1992-93, in agreement with [6]), due to the relatively high resolution of the ARPERA atmospheric dataset,
- the strong winter convection in the Aegean Sea triggered by these strong atmospheric fluxes (1.22 Sv of waters denser than 29.2 kg/m3 formed in 1993, in which 0.48 Sv are denser than 29.3 kg/m3),
- the huge outflow of dense waters from the Aegean Sea to the Ionian and Levantine basins through the Cretan Arc straits, especially through the eastern part during the two years following the intense convection event,
- the spreading of this water mass in the eastern Mediterranean, with a scheme of the path followed by this dense water mass from 1993 to 2000 (Fig. 1): the waters exiting the Aegean Sea through the western straits of the Cretan Arc spread in a cyclonic manner in the Ionian Sea; the waters exiting the Aegean Sea through the eastern straits of the Cretan Arc spread in the Levantine basin: a part of them crosses the Cretan Passage and joins the waters outflowing from the western straits while another part sinks at deeper levels in the Levantine basin. That part first spreads southwards following the bathymetry in a cyclonic manner and also propagates eastwards mainly driven by diffusive processes or trapped by eddies.

Among the preconditioning hypotheses proposed in the literature, we find that in the simulation:

- the surface circulation was modified in the late 1980's and the early 1990's, changing the AW path in the Levantine basin; combined with a long drought period over the far eastern Mediterranean which induces a salt increase of the surface layer in this area, this led to a salt increase of the Aegean Sea through a saltier Asia Minor Current,
- the three anticyclonic eddies observed in 1991 play a role in deviating and trapping the AW in the Levantine basin, rather than the LIW as mentionned in the literature, whereas those eddies are not at the observed locations,
- there was no huge decrease of the Black Sea freshwater discharge during the early 1990's according to our interannual dataset,
- several convection events in winters 1987, 1989 and 1990 took place before the major events of winters 1992 and 1993; they induced a steady filling of the Aegean Sea by the dense waters formed during these winters.

The sensitivity of using different hydrological fluxes on the simulation of the sequence of the EMT is investigated in [7].

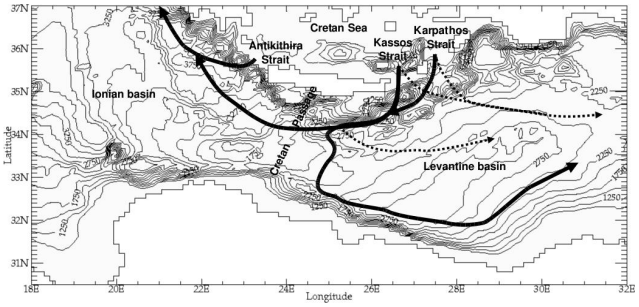


Fig. 1. Scheme of the path followed by the CDW after having exited the Aegean Sea. In full lines: direct advective path. In dashed lines: indirect diffusive path. Contours in back: bathymetry (in meters) of the NEMOMED8 model, interval of 250 m from 1000 m to 4000 m.

References

1 - Ludwig W., Dumont E., Meybeck M. and Heussner S., 2009. River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers for ecosystem changes during past and future decades ?, *Prog. Oceanogr.*, 80, 199–217.

2 - Stanev E. V. and Peneva E.L., 2002. Regional sea level response to global climatic change: Black Sea examples, *Global and Planetary Changes*, 32, 33–47.

3 - Daget N., Weaver A.T. and Balmaseda M.A., 2009. Ensemble estimation of background-error variances in a three-dimensional variational data assimilation system for the global ocean, *Quater. J. Roy. Meteor. Soc.*, 135, 1071–1094.

4 - Rixen M. et al., 2005. The Western Mediterranean Deep Water: A proxy for climate change, *Geophys. Res. Lett.*, 32 (L12608), 1–4.

5 - Roether W., Klein B., Manca B.B., Theocharis A. and Kioroglou S., 2007. Transient Eastern Mediterranean deep waters in response to the massive dense-water output of the Aegean Sea in the 1990s, *Prog. Oceanogr.*, 74, 540–571.

6 - Josey S.A., 2003. Changes in the heat and freshwater forcing of the eastern Mediterranean and their influence on deep water formation, *J. Geophys. Res.*, 108 (C7), 1–18.

7 - Beuvier J., Sevault F., Herrmann M., Kontoyiannis K., Ludwig W., Rixen M., Stanev E., Béranger K. and Somot S. (in revision). Modelling the Mediterranean Sea interannual variability over 1961-2000: focus on the Eastern Mediterranean Transient (EMT), *J. Geophys. Res.*

A MULTI-SCALE MODEL OF THE TURKISH STRAITS SYSTEM

Cheryl Ann Blain [1]*, Mustafa Kemal Cambazoglu [2] and Ewa Jarosz [1]
[1] Oceanography Division, naval Research Laboratory, Stennis Space Center, MS, USA - cheryl.ann.blain@nrlssc.navy.mil
[2] Dept. Marine Science, University of Southern Mississippi, Stennis Space Center, MS, USA

Abstract
A multi-scale coastal ocean model representing the entire Turkish Straits System (Aegean-Marmara-Black Seas and connecting straits) is one-way coupled to a 1 km basin-scale ocean model of the same region. The modeled three-dimensional circulation and density structure of the TSS is examined through comparison to observations of currents and density taken during the TSS08 sea trial.
Keywords: Coastal Models, Circulation, Bosphorus, Dardanelles, Marmara Sea

Two narrow, shallow straits, i.e. the Dardanelles and the Bosphorus, form a physical connection between the Marmara Sea and its adjacent water bodies, the Aegean Sea to the southwest and the Black Sea to the northeast. This collection of seas and straits is known as the Turkish Strait System (TSS). Saline, dense water from the Aegean flows in a deep, lower layer through the Marmara Sea to the Black Sea while fresher, lighter Black Sea water flows in a surface layer to the Aegean Sea. Though the TSS dynamics are the result of interconnections between the interconnected straits and ocean basins, earlier modeling efforts (e.g., Staneva et al., 2001; Oguz, 2005; Kourafalou and Tsiaras, 2007; Kanarska and Maderich, 2008) have focused on dynamical studies of individual straits or seas. Often the geometric complexity, broad range of spatial scales present, and computational requirements to represent such disparity have prevented study of the TSS as a whole.

For this study, we utilize state-of-the-art modeling practices to capture the range of spatial scales, geometric complexity and interconnected dynamics of the TSS (Figure 1). A model based on unstructured grids has the resolution, using a minimum element edge length of 20 m, necessary to model flow in the narrow straits whose minimum width is approximately 600 m. The ADvanced CIRCulation Model (ADCIRC), solves the three-dimensional flow and transport equations using a finite element discretization with a terrain-following, generalized, stretched coordinate system applied in the vertical (Luettich and Westerink, 2004; Dresback and Kolar, 2009). Flexibility of the finite element mesh not only captures the fine scales within the straits but is also able to represent mesoscale variability in the Marmara Sea while coupling to a basin scale model in the Aegean and Black Seas. Basin-wide dynamics are captured by the HYbrid Coordinate Ocean Model, HYCOM, which applies the finite difference method over a structured grid to solve the primitive mass and momentum balance equations (Bleck, 2002). HYCOM's hybrid vertical coordinate allows the use of three vertical coordinate types (depth, terrain-following and isopycnal) which better represents thermohaline dynamics in waters of rapidly varying bathymetric change. Within the HYCOM Aegean-Marmara-Black Sea model (HYCOM-AMB), both straits are represented as idealized channels since the current resolution (~1.3 km) is not sufficient to resolve the geometry of the straits.

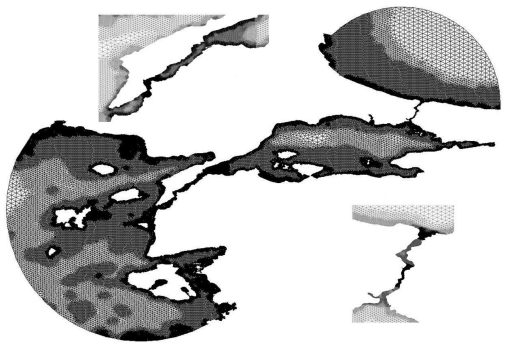


Fig. 1. ADCIRC finite element model domain for the Turkish Strait System including a zoom of the mesh refinement in the Dardanelles Strait (upper left) and Bosphorus Strait (lower right).

Model experiments presented focus on the period of the TSS08 sea trial (a joint project between the NATO Undersea Research Center and the U.S. Naval Research Laboratory), starting in late August and extending through November 2008. During one-way coupling as shown schematically in Figure 2, ADCIRC is initialized by temperature, salinity, velocity and water surface elevation fields from HYCOM-AMB solutions. At the open ocean boundaries, HYCOM-AMB values for elevation, temperature and salinity are updated daily throughout the ADCIRC model simulation. Surface forcing for both models is derived from the Navy's Coupled Ocean-Atmospheric Mesoscale Prediction System (COAMPS). The capability of ADCIRC to represent two-layer stratified flow dynamics both in the straits and in the Marmara Sea is examined along with the response of the currents and density structure over the water column to wind forcing. Observations include measured currents from ADCP moorings located at the ends of each strait in the TSS, CTD casts along the Dardanelles Strait and drifter deployments in the Marmara Sea. Observed features of interest include flow reversals in the straits during strong storm events, high-frequency current variability, and the persistence of circulation gyres in the Marmara Sea.

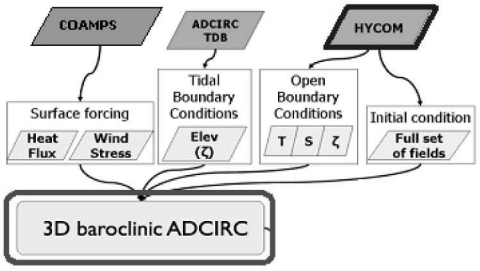


Fig. 2. The ADCIRC-HYCOM coupled model system.

Acknowledgements
This work is supported by the Office of Naval Research under the 6.2 NRL program "Development of a Multi-Scale Coupled Ocean Model System: Application to the Turkish Straits". Computer time has been granted by the DoD High Performance Computing Modernization Program at NAVOCEANO. The authors thank Dr. Jeff Book for processing ADCPs collected during the TSS08 field campaign and Drs. A Birol Kara and A. J. Wallcraft for development of the HYCOM-AMB model. This paper is contribution number NRL/PP/7320--09-0094.

References
1 - Bleck, R., 2002. An oceanic general circulation model framed in hybrid isopycnic-cartesian coordinates. *Ocean Model.*, 4: 55-88.
2 - Dresback K. M. and Kolar, R. L., 2009. Formulation and numerical implementation of the 3D Transport within the ADCIRC finite element code version 48.xx. *ADCIRC Theory Rep. (DRAFT).*
3 - Kanarska, Y. and Maderich, V., 2008. Modelling of seasonal exchange flows through the Dardanelles Strait. *Estuar. Coast. Shelf S.*, 79: 449-458.
4 - Kourafalou, V. and Tsiaras, K., 2007. A nested circulation model for the North Aegean Sea. *Ocean Sci.*, 3: 1–16.
5 - Luettich Jr., R. A. and Westerink, J. J., 2004. Formulation and numerical implementation of the 2D/3D ADCIRC finite element model version 44.XX. *ADCIRC Theory Rep.*. Found at www.adcirc.org
6 - Oguz, T., 2005. Hydraulic adjustments of the Bosphorus exchange flow. *Geophys. Res. Lett.*, 32: L06604, doi: 10.1029/2005GL022353.
7 - Staneva, J. V., Dietrich, D. E., Stanev, E. V., and Bowman, M. J., 2001. Rim current and coastal eddy mechanisms in an eddy-resolving Black Sea general circulation model. *J. Mar. Sys.*, 31: 137-157.

EDDY PROCESSES OF THE WESTERN ADRIATIC CURRENT NEAR CAPE GARGANO

J. W. Book [1]*, D. M. Burrage [1], S. Carniel [2], R. Hobbs [3], P. J. Martin [1], E. A. Midgely [3], M. Rixen [4], K. Schroeder [5], I. Vilibic [6] and W. Wood [1]

[1] U.S. Naval Research Laboratory, Stennis Space Center, MS, U.S.A. - book@nrlssc.navy.mil

[2] C.N.R.-Institute of Marine Science, Venezia, Italy

[3] University of Durham, Durham, U.K.

[4] NATO Undersea Research Centre, La Spezia, Italy

[5] C.N.R.-Institute of Marine Science, La Spezia, Italy

[6] Institute of Oceanography and Fisheries, Split, Croatia

Abstract

Eddy processes of the Western Adriatic Current near Cape Gargano are highly modulated by the wind, growing during calm periods following strong wind events. Both single anticyclones and trains of multiple eddies with a regular spacing are observed. Suppression of a single anticyclone in the lee of the Cape was observed by profiling SEPTR moorings to occur when the horizontal gradient of the thermocline depth was increased by the wind. Eddies also form cyclonic filaments extending offshore. Such a filament was observed through the new technique of seismic oceanography to have downslope tilting isotherms and a long, thin, offshore extension in the bottom boundary layer.

Keywords: Fronts, Mesoscale Phenomena, Adriatic Sea, Instruments And Techniques, Turbulence

Recent measurements from two international collaborative research programs reveal new details of eddy activity and instability of the Western Adriatic Current (WAC) as it rounds Cape Gargano in the central Adriatic Sea. The "Dynamics of the Adriatic in Real-Time" (DART) program was focused on understanding the predictability of this system with observation and modelling from October 2005 through September 2006. These included, among other things, measurements from long-term current moorings, profiling SEPTR moorings, tow-yo CTD profiles, remote sensing, and high-resolution modelling using the U.S. Navy Coastal Ocean Model. Remote sensing and modelling, supported by in situ observations, revealed two distinct cases of WAC eddy activity [1]. In the first case, a single anti-cyclonic circulation cell (typically 20-30 km horizontal and 25 m vertical scale) forms on the downstream side of the cape in the Gulf of Manfredonia (Figure 1a). In the second case, a multiple eddy train (30-40 km crest-to-crest wavelength) forms along the coast upstream of the cape and proceeds around it (Figure 1b). Both cases are linked to wind patterns; eddies grow and propagate as southeastward winds relax, and are suppressed when these winds are strong. Profiling SEPTR mooring measurements observed anticyclonic eddies in the lee of the Cape when the thermocline slope was weak and the absence of eddies when strong southeastward winds strengthened this thermocline slope.

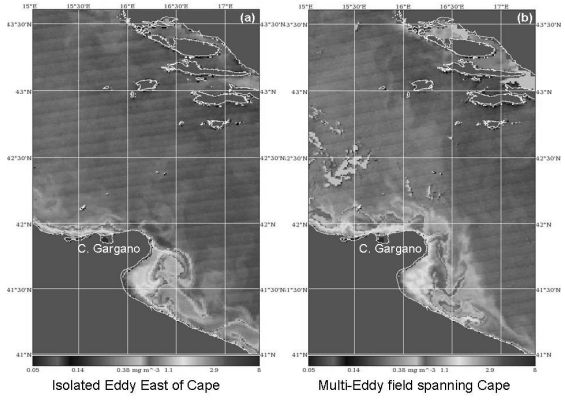


Fig. 1. Remote sensing Chlorophyll-a images from MODIS Aqua showing representative cases of (a) single anticyclonic WAC eddy downstream of Cape Gargano and (b) multiple eddy train around the Cape. This is a reproduction of Figure 2 from [1].

The AdriaSeismic09 research campaign used the new technique of seismic oceanography [2] to image the temperature gradient structure of the WAC frontal system during March 2009 at very fine horizontal scales (order 10 m). Sampling captured the details of a third WAC eddy case, a cyclonic filament extending offshore following a strong wind event (also observed during DART [3]). Both microstructure profiler and seismic sections crossed the filament multiple times. The filament frontal structure was baroclinic with down-sloping isotherms. Near the bottom, the tilt extended into a long, thin, offshore extension of coastal waters in the bottom boundary layer, followed by a subtle up-tilting structure offshore. These structures were all successfully imaged (Figure 2) by seismic measurements, revealing new fine-scale details of the filament structure that couldn't have been measured otherwise.

Although Adriatic wind regimes and Cape topography provide the background setting for eddy formation, frontal instabilities and mixing processes determine many details of eddy structure and evolution.

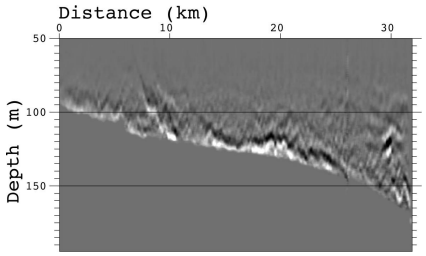


Fig. 2. Seismic reflectivity image showing the structure of the vertically tilting WAC filament edge (left), thin offshore extension of cold bottom water (center), and offshore up-tilting structure (right). Reflectivity is measured at 5-10 m horizontal resolution and is associated with band-limited vertical temperature gradient. E.g., the colder water at the bottom causes a decrease in sound speed and a negative reflection (black over white). The largest reflections correspond to temperature changes of about one degree C over ten meters of depth.

Acknowledgments: We thank the Italian CNR for providing R/V Urania ship time and CNR-ISMAR for coordinating the AdriaSeismic09 cruise. This work was supported by the Office of Naval Research under Program Elements 0602435N and 0601153N.

References

1 - Burrage D.M., Book J.W. and Martin P.J., 2009. Eddies and Filaments of the Western Adriatic Current near Cape Gargano: Analysis and Prediction. *J. Marine Syst.*, 78: S205-S226, doi:10.1016/j.jmarsys.2009.01.024.

2 - Ruddick B., Song H., Dong C. and Pinheiro L., 2009. Water Column Seismic Images as Maps of Temperature Gradient. *Oceanogr.*, 22 (1): 192-205.

3 - Vilibic I., Book J.W., Beg Paklar G., Orlic M., Dadic V., Tudor M., Martin P.J., Pasaric M., Grbec B., Matic F., Mihanovic H. and Morovic M., 2009. West Adriatic coastal water excursions into the East Adriatic. *J. Marine Syst.*, 78: S132-S156, doi:10.1016/j.jmarsys.2009.01.015.

OBSERVATIONS OF HIGHER-FREQUENCY VARIABILITY THROUGH THE TURKISH STRAITS SYSTEM

Jeffrey w. Book [1]*, Ewa Jarosz [1] and Sükrü Besiktepe [2]
[1] U.S. Naval Research Laboratory, Stennis Space Center, MS, U.S.A. - book@nrlssc.navy.mil
[2] NATO Undersea Research Centre, La Spezia, Italy

Abstract
From September 2008 through February 2009, Acoustic Doppler Current Profilers (ADCPs) measured flow in pairs at the four entrances and exits to the Turkish Strait System. Barotropic tide structures were observed for both diurnal and semidiurnal frequencies in the Aegean/ Dardanelles entrance. At the Dardanelles/Sea of Marmara entrance some baroclinic structure was observed with diurnal tides having higher energy in the upper layer compared to the lower layer. Baroclinic structure in the semi-diurnal tides was observed at the Bosphorus/Sea of Marmara entrance and diurnal oscillations were weak. Both diurnal and semi-diurnal oscillations were weak at the Bosphorus/Black Sea entrance as the temporal evolution of the flow was more concentrated at low frequencies in the form of a mid-water-column jet.
Keywords: Aegean Sea, Black Sea, Bosphorus, Dardanelles, Tides

The U.S. Naval Research Laboratory in collaboration with NATO Undersea Research Centre and the Turkish Navy Office of Navigation, Hydrography and Oceanography, undertook a scientific research program, Exchange Processes in Ocean Straits (EPOS) that included an observational effort from September 2008 through February 2009 of maintaining pairs of bottom-mounted, upward-looking Acoustic Doppler Current Profilers near all entrances (exits) of the Turkish Strait System. Simultaneous current measurements allow connectivity ranging from high-frequency to seasonal processes to be investigated. One aspect of EPOS was to examine the frequency response of this system which includes very narrow passages and two vertical layers of opposed and energetic flow and exchange [1]. E.g., how do processes that are forced synoptically or faster propagate through the system and what is the baroclinic structure of their evolution?

To investigate this, rotary spectra were calculated from all the ADCP records separately for all depths. We used Welch's averaged periodogram method over block lengths of 43 days and 50% overlapping Hanning windows. No significant polarity differences were found between clockwise and counterclockwise spectra suggesting the absence of inertial activity at all four sections. There is a remarkable difference in the spectra results for each ADCP current section, particularly with regard to tidal oscillations. Diurnal and semidiurnal tides were clearly present at both ends of the Dardanelles Strait. The structures were primarily barotropic at the Aegean/Dardanelles entrance (Fig. 1, left). In contrast, at the Dardanelles/Sea of Marmara entrance the diurnal fluctuations in the lower layer entrance were notably weaker than fluctuations in the upper layer (Fig. 1, right). This suggests that the Dardanelles Strait geometry and/or its baroclinic structure has acted to extract some energy from the barotropic tide and convert it into baroclinic processes. Also, the differences between the diurnal and semidiurnal responses show a frequency dependence on this action.

At the Bosphorus/Sea of Marmara entrance the tidal frequency spectral peaks were different than those observed at the Dardanelles/Sea of Marmara entrance. Diurnal fluctuations were mostly absent and the semi-diurnal fluctuations had baroclinic structure, again with stronger spectral peaks in the upper than the lower layer (Fig. 2, left). This suggests that oscillations at diurnal and semi-diurnal frequency are not passing unaltered through the Sea of Marmara. The observed spectra at the Bosphorus/Black Sea entrance differed the most from the others as spectral energy was concentrated in the middle of the water column and at lower frequencies (Fig. 2, right). Flow was maximized in the upper portions of the lower layer in a jet-like structure as compared to maximums in the upper portions of the upper layer at other sections. Weak (primarily semidiurnal) tidal oscillations persisted in the upper layer and the flow maximum jet, but were virtually absent in the bottom of the water column. This suggests that the Bosphorus Strait geometry and/or its baroclinic structure also acts to alter or block higher frequency oscillations.

Analysis of these results has just begun and is ongoing. However, we can conclude that diurnal and higher frequency oscillations are an important component of the variability of the flow in parts of the Turkish Straits system, and that the Straits System acts to significantly affect the transmission of these frequencies.

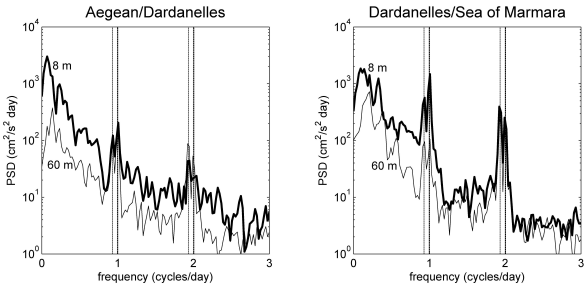


Fig. 1. Clockwise rotary spectra for representative moorings and depth levels in the Dardanelles Strait. The major tidal frequencies are marked by dotted lines.

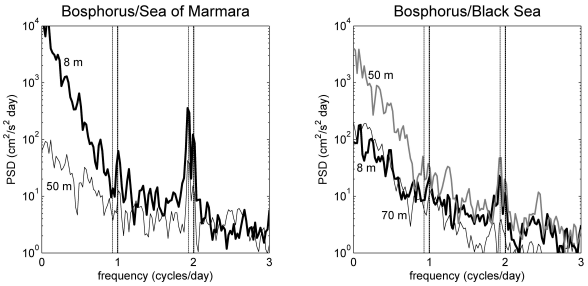


Fig. 2. As in Figure 1, but for the Bosphorus Strait.

Acknowledgments: This work was supported by the Office of Naval Research under Program Element 0601153N.

References
1 - Ünlüata Ü, Oguz T., Latif M.A. and Özsoy E., 1990. On the physical oceanography of the Turkish Straits. *In*: Pratt, L.J. (Ed.), The Physical Oceanography of Sea Straits. NATO ASI Ser. Kluwer Academic Publishing, Dordrecht, pp. 25–60.

MASS CONTRIBUTION TO MEDITERRANEAN SEA LEVEL VARIABILITY FOR THE PERIOD 1948-2000

Francisco Calafat [1]*, Marta Marcos [1] and Damià Gomis [1]
[1] Institut Mediterrani d'Estudis Avançats (CSIC-UIB), Esporles, Spain - kiko.mir@uib.es

Abstract
The mass contribution to Mediterranean Sea level variability is estimated from steric-corrected altimetry and from GRACE observations for the period August 2002 to December 2006. The good agreement between GRACE observations and steric-corrected altimetry supports the quantification of the long-term mass contribution in terms of non-steric sea level in the Mediterranean. For the past decades, total sea level fields are reconstructed using a reduced-space optimal interpolation of altimetry and tide gauge data. The steric component is evaluated from hydrographic observations available for the same period. Results indicate that the mass content has increased at a rate of 0.8±0.2 mm/yr for the period 1948-2000. When the effect of the atmospheric pressure is removed, the trend of the mass component is 1.2±0.3 mm/yr.
Keywords: Sea Level, Geophysics, Global Change

Introduction
In this paper we first use altimetry, GRACE and hydrographic observations spanning the period 2002-2006 to assess the consistency between total sea level and its two components (steric and mass) in the Mediterranean Sea. Fenoglio-Marc et al. [1] and García et al. [2] carried out similar works for the period 2002-2004, but they only focused on the seasonal sea level cycle. Here we consider both intra and inter-annual variability. Other differences with respect to those works are that they use model data (not hydrographic observations) to estimate the steric cycle and that an improved and longer GRACE data set has been made available since then. The good agreement found between GRACE observations and steric-corrected altimetry supports the quantification of the mass contribution in terms of the non-steric sea level in the Mediterranean. Hence, we also evaluate the mass contribution to sea level for the period 1948-2000.

Data sets
The Level-2 Release-04 (RL04) gravity coefficients computed at the Center for Space Research (CSR) and distributed by the GRACE project are used to estimate water mass variations in the Mediterranean Sea between August 2002 and December 2006. A hydrologycal model is used to correct the effect of land waters. The post glacial rebound correction is also applied. To obtain the basin average a smooth averaging kernel is used.

For the period 2002-2006 the Mediterranean mean sea level is computed from Altimetry data while for the period 1948-2000 total sea level fields are reconstructed using a reduced-space optimal interpolation of altimetry and tide gauge data [3]. The steric component is evaluated from hydrographic observations [4]. The errors associated with total sea level and the steric component are evaluated in order to obtain the uncertainty of non-steric sea level.

Results and discussion
Consistency between non-steric sea level and GRACE observations is found for the period August 2002 to December 2006 (Fig.1). The observed mass component from GRACE and the estimated contribution from non-steric sea level have a correlation of 0.75 (significant at the 95% confidence level). The existence of a seasonal cycle in the mass component of Mediterranean mean sea level is not evident and, if it exists, it is not the most energetic signal. The linear trend of the steric-corrected altimetry and that obtained from GRACE are fully consistent: their values are 2.1±0.6mm/yr and 2.1±0.5 mm/yr, respectively.

The consistency between non-steric sea level and GRACE observations supports that the mass component can be obtained as the non-steric contribution of Mediterranean sea level for a longer period. The overall trends computed for the period 1948-2000 are -0.25±0.04 mm/yr for the steric component and 0.96±0.05 mm/yr for the atmospherically-corrected total sea level. The net mass contribution to sea level trends would then be of the order 1.2±0.3 mm/yr. When the atmospheric component is included the mass component shows a smaller trend: 0.8±0.1 mm/yr. Those values are in agreement with the global mean value obtained by Domingues et al. [5] for the period 1961-2003 (between 0.8 and 1.1 mm/yr).

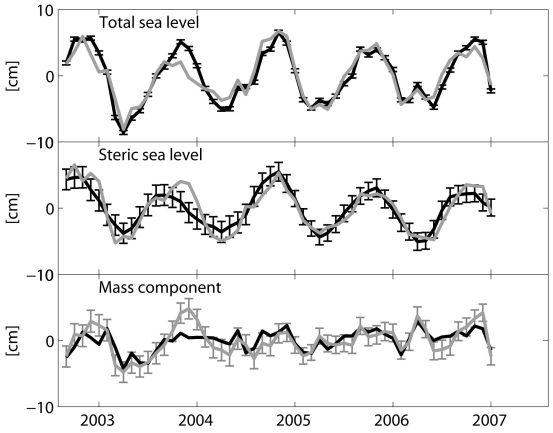


Fig. 1. Mediterranean mean sea level variability and its components with error bars for the period August 2002 to December 2006: (atmospherically-corrected) total sea level (top), the steric component of mean sea level (middle), and the mass component of sea level (bottom). Black lines show the observed estimates from satellite altimetry (top), the Ishii dataset (middle) and GRACE (bottom), respectively. Grey lines show the estimates obtained by adding or subtracting the other two observational components.

Acknowledgements
This work has been carried out in the framework of the VANIMEDAT project (CTM2005-05694-C03/MAR) funded by the Spanish Marine Science and Technology Program and by the FEDER program of the European Union. F. M. Calafat acknowledges an FPI grant and M. Marcos acknowledges a "Juan de la Cierva" contract, both funded by the Spanish Ministry of Science and Innovation.

References
1 - Fenoglio-Marc L., Kusche J. and Becker M., 2006. Mass variation in the Mediterranean Sea from GRACE and its validation by altimetry, steric and hydrologic fields. *Geophys. Res. Lett.*, 33, L19606.
2 - García D., Chao B.F., Del Río J., Vigo I. and García-Lafuente J., 2006. On the steric and mass-induced contributions to the annual sea level variations in the Mediterranean Sea. *J. Geophys. Res.*, 111, C09030.
3 - Calafat F.M. and Gomis D., 2009. Reconstruction of Mediterranean Sea level fields for the period 1945-2000. *Global Planet. Change*, 66(3-4): 225-234.
4 - Ishii M. and Kimoto M., 2009. Reevaluation of Historical Ocean Heat Content Variations with Time-Varying XBT and MBT Depth Bias Corrections. *J. Oceanogr.*, 65: 287-299.
5 - Domingues C.M., Church J.A., White N.J., Glecker P.J., Wijffels S.E., Barker P.M. and Dunn J.R., 2008. Improved estimates of upper-ocean warming and multi-decadal sea level rise. *Nature*, 453: 1090-1094.

EVALUATION OF WIND FIELD PREDICTIONS BY ATMOSPHERIC MODELS OVER THE MARMARA SEA

Mustafa Kemal Cambazoglu [1]*, Cheryl Ann Blain [2] and Mikdat Kadioglu [3]
[1] Department of Marine Science, The University of Southern Mississippi, Stennis Space Center, MS, USA - kemal.cambazoglu.ctr.tu@nrlssc.navy.mil
[2] Oceanography Division, Naval Research Laboratory, Stennis Space Center, MS, USA
[3] Faculty of Aeronautics and Astronautics, Istanbul Technical University, Istanbul, Turkey

Abstract
Data collected from meteorological stations in the Turkish Straits System around the Marmara Sea are used to assess the performance of atmospheric models in predicting the winds. The Coupled Ocean/Atmosphere Mesoscale Prediction System, COAMPS is applied using different spatial resolutions ranging between 1 km and 27 km to investigate the effect of model spatial grid resolution on accuracy of the computed wind field. The influence of the ocean dynamics on the atmospheric winds is also investigated by comparing wind field predictions from a fully coupled COAMPS with those from the uncoupled (stand-alone atmospheric) COAMPS. Following the examination of the wind products, the importance of using high resolution wind forcing for ocean circulation predictions is evaluated.
Keywords: Marmara Sea, Air-Sea Interactions, Wind/Font, Circulation, Atmospheric Input

The Turkish Straits System (TSS) contains the Dardanelles and the Bosphorus straits that connect the Marmara Sea to the Aegean and the Black Seas, respectively. Fresh, light Black Sea water flows at the surface towards the Aegean Sea while saline, dense Mediterranean water flows deep in the opposite direction resulting in a two-layer stratified flow in both straits. Winds over the region play a major role in generating various features within the TSS system, i.e. blocking of the deep (surface) flow within the straits by Northerly (Southerly) winds; the spread of the Dardanelles outflow plume over the Aegean Sea; and the circulation pattern within the Marmara Sea among the others. Since the winds are the dominant external forcing applied to the ocean models, accurate predictions of winds by atmospheric models are crucial for accurate predictions of the flow dynamics.

Hourly wind direction and speed data collected from 13 meteorological stations located around the Marmara Sea between May 2008 and June 2009 are used to assess the performance of atmospheric models in predicting winds. The measurements recorded every ten minutes by two Meteo-buoys on the Marmara and Black Seas are also included in the evaluation. The atmospheric models under consideration are the Coupled Ocean/Atmosphere Mesoscale Prediction System, COAMPS [1], and the numerical weather prediction model, COSMO-ME, based on the non-hydrostatic Lokall-Model(LM) [2]. COSMO is the COnsortium for Small scale MOdeling and COSMO-ME is a particular application running on the Southern Europe/Mediterranean Sea domain managed by USAM (Meteorological Service of the Italian AirForce). It has a spatial resolution of 7-km while COAMPS has a coarse operational grid resolution of 27-km. Local configurations of the COAMPS model for grids of 9-km, 3-km and 1-km are also considered.

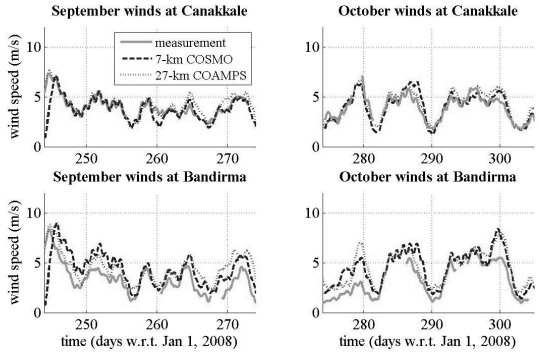


Fig. 1. Wind speed variation (36-hour averaged) over September and October 2008 at Canakkale and Bandirma meteorological station locations: Measurements (solid), 7-km COSMO model results (dash) and 27-km COAMPS model results (dot).

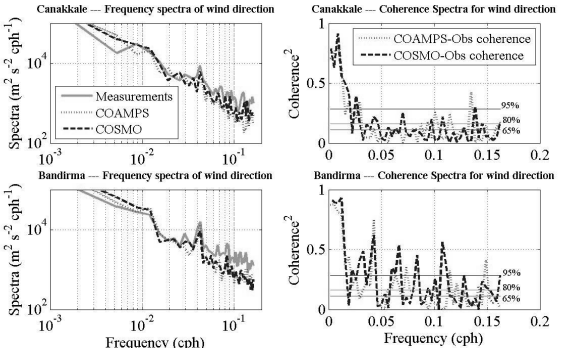


Fig. 2. Frequency and coherence spectra of wind direction measurements vs. the COAMPS (27-km) and COSMO (7-km) model results for Canakkale and Bandirma meteorological stations.

Both model inter-comparisons (COAMPS vs. COSMO) and model-data comparisons are conducted. Model-data comparisons consider both the raw and filtered time series of wind speed and direction. A more detailed statistical analysis is done by examining the frequency spectra of the modeled and measured wind fields and the coherence between them. The coarser COAMPS model is able to capture the low-frequency (36-hour averaged) wind speed variability as shown in Fig. 1. COAMPS-COSMO comparisons indicate similar wind field predictions (shown in Fig.1) with the exception of wind direction during higher frequency wind events such as the semi-diurnal cycle or the land/sea breeze events as shown in Fig. 2.

Acknowledgements
This work is supported by the Office of Naval Research under the 6.2 NRL program "Development of a Multi-Scale Coupled Ocean Model System: Application to the Turkish Straits". The authors appreciate Dr. E. Jarosz of NRL for the software that facilitated model-data coherence analysis as well as Drs. J. Dykes and T. Smith of NRL for providing the model results of locally configured COAMPS simulations . Further thanks are extended also to Dr. J. Chiggiato of NURC for providing the COSMO-ME data for the evaluations. This paper is contribution number NRL/PP/7320--09-0091

References
1 - Hodur, R. M., 1997. The Naval Research Laboratory's coupled ocean/atmosphere mesoscale prediction system (COAMPS). *Mon. Weather Rev.*, 125(7): 1414-1430
2 - Steppeler J., Doms G., Schättler U., Bitzer H.W., Gassmann A., Damrath U. and Gregoric G., 2003. Meso-gamma scale forecasts using the nonhydrostatic model LM. *Meteorol. Atmos. Phys.*, 82: 75-96.

SEASONAL VARIABILITY OF PHYSICAL AND CHEMICAL PARAMETERS OF THE NORTHERN AND CENTRAL ADRIATIC SEA DURING 2001

Alessandra Campanelli [1]*, Federica Grilli [1], Mauro Marini [1] and Elio Paschini [1]
[1] ISMAR-CNR L.go Fiera della Pesca, 2. 60125 Ancona, Italy - a.campanelli@ismar.cnr.it

Abstract
During 2001 three oceanographic cruises were carried out in the northern and central Adriatic Sea. Several measurement were situated along multiple transects. In each station physical and chemical parameters were collected in order to study the dynamics of the coastal and off-shore area through the space and the time. The basin showed high nutrient variability during all the year. Nutrient concentrations appeared influenced by river discharge, vertical mixing in the different cruises and uptake from phytoplankton groups.
Keywords: Adriatic Sea, Nutrients, Salinity, River Input

The Adriatic is a continental basin of the Eastern Mediterranean Sea, located between the Italian peninsula and the Croatian coast; it is elongated in the SE-NW direction. The northern sub-basin is very shallow and gently sloping, with an average bottom depth of about 35 m. River runoff is particularly strong in this area and affects the circulation through buoyancy input and the ecosystem by introducing large amounts of organic matter. the Po river, with an average annual discharge of 1500 m^3s^{-1}, accounts for about 50 % of the total northern Adriatic river runoff [1]. The middle Adriatic is a transition zone between northern and southern sub-basins, with the three Jabuka depressions reaching 270 m depth. Two currents dominate the circulation in the Adriatic: the West Adriatic Current (WAC) flows toward southeast along the western (Italian) coast, and the East Adriatic Current (EAC) flows northwest along the eastern (Croatian) coast, [2, 3].

The temporal variations of physical and chemical parameters in the Adriatic Sea were observed during three periods (January, June and September 2001) in order to increase the understanding of the area. The CTD (Conductivity-Temperature-Depth) data were collected at all the stations with a SeaBird Electronics SBE 911-plus CTD, equipped with other ancillary sensors. Water samples were obtained by the upcasts with a SeaBird Carousel rosette water sampler. Water samples were collected to analyse nutrient salts and DO (Dissolved Oxygen) with the potentiometric titration method.

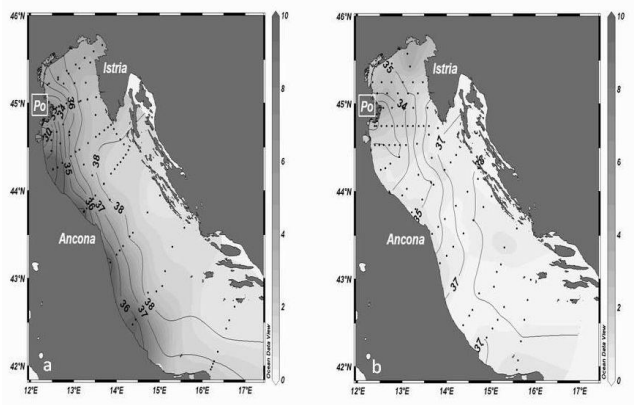


Fig. 1. Winter (a) and late spring (b) surface field of: Salinity (black contour, interval 1) and Nitrate (color shading, µmol l^{-1}). The dots represent the sampling

During the winter cruise (figure 1a) in situ measurements indicated cooler, fresher water to the north and warmer, saltier water to the south of the front located at the southern tip of Istria. Furthermore two months before the cruise the river discharge was about 3 times higher that the mean value (about 5500 m^3 s^{-1}). Nutrient concentrations were high along the western boundary and decreased rapidly toward the east forming a strong front along the western side of the Adriatic. The nutrient contribution from the Po plume to the north-western basin is evident in the high nitrate concentrations (6-8 µmol l^{-1}) associated with the salinity minimum of the plume. During the late spring cruise (June, figure 1b) the Po plume remained a significant feature in the northern and western Adriatic. Offshore from the mouth of the Po River, the surface layer was characterized by low salinity (30-32) and high temperature (22-23 °C). The Po plume extended much more eastward in late spring than in winter because the vertical mixing is reduced [4, 5]. Low nutrient concentrations were observed in the central basin despite the northern Adriatic shown relatively high nitrate + nitrite concentrations (2-4 µmol l^{-1}). The late summer cruise (September) showed similar patterns of the late spring cruise.

The Adriatic basin showed more nutrient variability during the winter period because of major river discharge during autumn 2000 and vertical mixing. In particular, during spring and summer the nutrient concentrations decreased in most of the basin and this was probably due to uptake from phytoplankton groups under conditions of high available light. This feature was also evidenced by high DO concentrations in these periods respect to winter cruise. The redfield ratios (N/P and Si/P) off-shore were similar to the classic ocean model but with nutrient concentrations slightly higher. The western coast showed high redfield ratios that implied processes of eutrophycation probably due to high river input.

References
1 - Poulain P.M. and Raicich F., 2001. Forcing. Pp 45-65. *In*: Cushman-Rosin B. et al. (eds.), Physical Oceanography of the Adriatic Sea. Kluwer Academic Publisher, Dordrecht, Netherlands.
2 - Artegiani A., Bregant D., Paschini E., Pinardi N., Raicich F., and Russo A., 1997. The Adriatic Sea general circulation. Part II: Baroclinic Circulation Structure, *J. Phys. Oceanogr*., 27: 1515– 1532.
3 - Lee C. M., Orlic M., Poulain P.M. and Cushman-Roisin B., 2007. Introduction to special section: Recent advances in oceanography and marine meteorology of the Adriatic Sea. *J. Geophys. Res.*, 112, C03S01, doi: 10.1029/2007JC004115.
4 - Poulain P.M., Kourafalou V. H. and Cushman-Roisin B., 2001. Northern Adriatic Sea. Pp. 143-165. *In* Cushman-Roisin B. et al. (eds.), Physical Oceanography of the Adriatic Sea. Kluwer Academic Publisher, Dordrecht, Netherlands.
5 - Marini M., Jones B. H., Campanelli A., Grilli F. and Lee C. M., 2008. Seasonal variability and Po River plume influence on biochemical properties along western Adriatic coast. *J. Geophys. Res.*, 113, C05S90, doi:10.1029/2007JC004370.

3D MODELLING OF THE BLACK SEA NORTH WESTERN SHELF ECOSYSTEM

A. Capet [1]*, M. Gregoire [1], J. Beckers [1], P. Joassin [1], J. Naithani [1] and L. Vandebulcke [1]
[1] University of Liège, Liège, Belgium - arthurcapet@gmail.com

Abstract
In the framework of the SESAME European project, a coupled physical-biogeochemical model has been developed to simulate the ecosystem of the Black Sea during the last decades. The biogeochemical model describes the foodweb from bacteria to gelatinous carnivores and explicitly represents processes in the anoxic layer down to the bottom. After validations of the model, equilibrium states from climatologic runs are presented, corresponding to identified key time slices. From them interannual run are studied to compare the interannual variability scales with those between different climatological equilibrium, for the different component of the ecosystem.

Keywords: Black Sea, Models

In the framework of the SESAME European project, a coupled physical-biogeochemical model has been developed to simulate the ecosystem of the Black Sea during the last decades when eutrophication and invasion by gelatinous organisms seriously affected the stability and dynamics of the system [1]. The biogeochemical model describes the foodweb from bacteria to gelatinous carnivores and explicitly represents processes in the anoxic layer down to the bottom.

For calibration and analyses purposes, the coupled model has first been run in 1D in the central Black Sea [2]. The biogeochemical model involves some hundred parameters which are first calibrated by hand using published values. Then, an identifiability analysis has been performed in order to determine a subset of 15 identifiable parameters. An automatic calibration subroutine has been used to fine tune these parameters. In 1D, the model solution exhibits a complex dynamics with several years of transient adjustment. This complexity is imparted by the explicit modelling of top predators. The model has been calibrated and validated using a large set of data available in the Black Sea TU Ocean Base.

The calibrated biogeochemical model is implemented in a 3D hydrodynamical model of the Black Sea (GHER). A first experiment is driven under climatologic atmospheric, riverine forcings and initials conditions constructed to correspond to three different time-slices: 60-70 (pre-eutrophication phase), 83-90 (severe eutrophication phase), 93-2000 (recovering). This experiment is conducted in order to differentiate the equilibrium states reached by the model for those different forcing sets. Resulting spatial and temporal variations in the annual cycle of the different species, as well as chemicals dynamics will be presented using representations and criticized.

A particular way of representation has been studied to reduce the dimensionality of the data at hands, making use of the Self-Organized Maps technology. We will present the basic principles of this method which automatically recognize self coherent regions in a temporal-multivariate way of speaking, allowing to gather in a single glance the gross annual dynamic of the entire model [3].

Then, inter-annual computations have been initialized from those equilibrium states. Physical dynamics can be accurately criticized in regards with circulation structures and thermo haline annual cycle, using processed sea surface satellite images, circulation features identified in literature and in-situ measurements. This allows us to assess a certain level of confidence attributable to the biological patterns observed in the results. This comes as a complement to what the scarcity of biological data allow us to directly criticize concerning their spatio-temporal correctness [4]. Inter-annual variability is then explored under the light of precedent analysis concerning the different equilibrium states.

During this study, a particular interpolation technique using the software DIVA has been used to reconstruct the 2D and 3D fields for biological data needed for initialisation of the model, and those that are used for visual comparison with the results. This kind of reconstruction, made tricky by the scarcity of data but nonetheless essentials to model study, will be given some minutes for presentation and the obtained results will be presented.

References
1 - Oguz T. and Gilbert D., 2000, Abrupt transitions of the top-down controlled Black Sea pelagic ecosystem during 1960– Evidence for regime-shifts under strong fishery exploitation and nutrient enrichment modulated by climate-induced variations. *Deep-Sea Res. I*, 54: 220-242.
2 - Gregoire M., Raick C. and Soetart K., 2008, Numerical modeling of the central Black Sea ecosystem functioning during the eutrophication phase, *Prog. Oceanogr.*, 76: 286-333.
3 - Allen I., Holt T., .Blackford J. and Proctor R., 2007, Error quantification of a high-resolution coupled hydrodynamic-ecosystem coastal-ocean model: Part 2. Chlorophyll-a, nutrients and SPM, *J. Marine Syst.*, 68: 381-404.
4 - Yunev O., et al., 2007. Nutrient and phytoplankton trends on the western Black Sea shelf in response to cultural eutrophication and climate changes, Estuarine, *Coast. Shelf Sci.*, 74: 63-76.

STRUCTURE AND VARIABILITY OF THE ABYSSAL WATER MASSES OF THE EASTERN MEDITERRANEAN

Vanessa Cardin [1]*, Manuel Bensi [1], Dagmar Hainbucher [2] and Angelo Rubino [3]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy - vcardin@ogs.trieste.it
[2] Universitat Hamburg - Institut fur Meereskunde, Hamburg - Germany
[3] Università Cà Foscari - Venezia, Italy

Abstract
During the EMT water inflowing the Adriatic basin were characterised by an anomalous low salinity. After the year 2003 saltier waters associated with the Aegean Sea outflow at higher horizons, were able to enter the Adriatic basin and create the necessary conditions for the deep convection in the Southern Adriatic Pit. The newly dense waters formed profoundly differ from waters of Adriatic origin observed in the region previously being saltier and warmer than in the past. To confirm this, cruises in two specific periods (2003 and 2008) were analysed. Data analysis confirmed the increase in salt and temperature in the abyssal area of the Ionian Sea (Zone A) so as the presence of Adriatic Dense water (ADW) in the northwestern Ionian (Zone C)
Keywords: Eastern Mediterranean, Adriatic Sea, Circulation, Water Convection, Deep Waters

Using in situ data collected during the last 10 years we investigated the structure and variability of the abyssal water masses of the Eastern Mediterranean Basin (EM). Waters inflowing the Adriatic basin were characterized by an anomalous low salinity over the entire water column and by the absence of the typical salinity maximum associated with inflowing Levantine Intermediate Water (LIW). After the year 2000, saltier waters were able to enter the Adriatic basin and were able to create the necessary conditions for deep convection in the South Adriatic Pit. The dense waters which were formed since then, however, profoundly differ from waters of Adriatic origin observed previously in the region: they are substantially saltier and warmer than in the past. A tendency toward warming and, especially, salinification, seems to be confirmed by the preliminary analysis of very recent data acquired in the area [1], which agrees with the conjecture that very salty intermediate waters flowing toward the Adriatic basin contribute to reinforce the Adriatic source of EMDW. To confirm this tendency, temperature, salinity, and oxygen data sampled during 2008 SESAME cruises in the central (Zone A) and northeastern (Zone C) part of the Ionian basin are compared with the same parameters data obtained during previous years on the METEOR71-3 (2007) and POS298 (2003) cruises (figure 1).

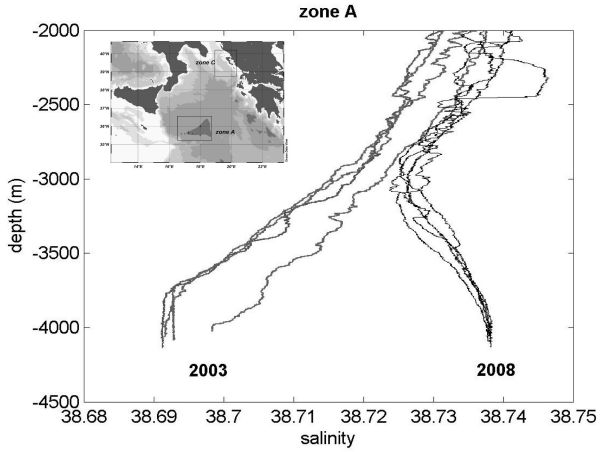


Fig. 1. Deep layer salinity profiles carried out during the 2003 and 2008 cruises in the central Ionian Sea.

The analysis of thermohaline parameters of the 2008 cruises confirms the differences in the EMDW properties for the deep layer (>3000 m) between 2003 and 2008 [2],while no significant changes are observed between the 2007 and 2008 cruises. The analysis of profiles positioned in Zone C (northeastern Ionian), collected during March 2008 cruise, shows clearly the presence of a vein of Adriatic Deep Water in the layer between 1300-1500 m. Oxygen values (figure2), potential temperature and salinity present similar characteristics as those found previously in the Southern Adriatic Pit at ~800m, which seems to outflow almost geostrophically and which may be attributed to the Adriatic Deep Water (ADW).

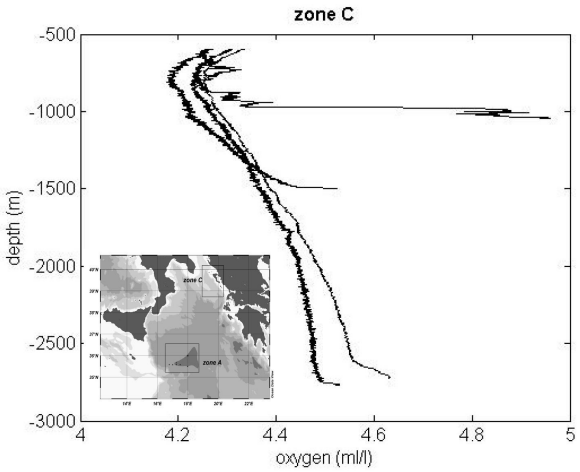


Fig. 2. Oxygen profiles from CTD casts carried out during the SESAME (2008) cruises in the northwestern zone.

Another branch of water follows the south westerly direction from the Otranto Strait reaching the deepest part of the central Ionian**.** We observe a general increase of temperature and salinity, hence density, during the period 2003-2008 in the bottom layers of the central Ionian Sea. This could be directly related to the changes in the thermohaline properties of the water mass coming from the Adriatic Sea described above. This trend is confirmed through the time series of temperature and salinity recorded in the Southern Adriatic Pit, which shows an increase of salinity and temperature for both Adriatic Deep Waters (ADW) and LIW between 2003 and 2008 [3]. Starting in 2008, however, this trend seems to have reverted again, as lower intermediate salinity waters are now observed to enter the Adriatic Basin.

References
1 - Cardin V. and Gacic M., 2008. Are decadal variations of Adriatic thermohaline properties related to the Eastern Mediterranean Transient (EMT)?. *In:* Climate warming and related changes in Mediterranean marine biota, F. Briand Ed. *CIESM Workshop Monographs*, 35, 152 pages, Monaco
2 - Rubino A., and Hainbucher D., 2007. A large abrupt change in the abyssal water masses of the eastern Mediterranean, *Geophys. Res. Lett*., 34, doi: 10.1029/2007GL031737
3 - Hainbucher D., Rubino A., and Klein B., 2006. Water mass characteristics in the deep layers of the western Ionian Basin observed during May 2003, *Geophys. Res. Lett*., 33, L05608, doi: 10.1029/2005GL025318.

THE HYPERSPECTRAL FOR ADRIATIC COASTAL MONITORING (HYPAD.COM) PROJECT

R. M. Cavalli [1], L. Alberotanza [3], C. Bassani [1], F. Braga [3]*, L. Fusilli [1], A. Palombo [2], S. Pascucci [2], S. Pignatti [2] and F. Santini [1]
[1] Consiglio Nazionale delle Ricerche - Istituto sull'Inquinamento Atmosferico, Roma, Italia
[2] Consiglio Nazionale delle Ricerche - Istituto di Metodologie per l'Analisi Ambientale, Potenza, Italia
[3] Consiglio Nazionale delle Ricerche - Istituto di Scienze Marine, Venezia, Italia - f.braga@ismar.cnr.it

Abstract
The HYPerspectral for ADriatic COastal Monitoring project meets requirements for understanding and monitoring the coastal environments. The understanding of the coastal areas dynamics, their processes and significance for the environment, is becoming even more a milestone for any future conservation and protection of these areas. The demand for coastal zones managements has progressively risen due to the increased direct impacts by human activities, which may cause an irreversible damage to the local natural balance. In particular, the project focuses on improving the knowledge of the Albania and Montenegro coastal area by integrating different high resolution spatial and spectral remote sensing technologies.
Keywords: Coastal Waters, Remote Sensing, Adriatic Sea

Introduction
The HYPAD.COM project takes place at this strategic moment, when the Earth Observation (EO) has become an essential component of the global effort to deal with global challenges.

The purpose of the HYPAD.COM is to promote capacity building in EO, on existing initiatives and sector-specific needs, like GEOSS planned, in order to achieve comprehensive, coordinated and sustained in situ and airborne observations of the coastal area.

The HYPAD.COM activity programme meets the need for timely and quality local scientific information as a basis for decision making, and enhances delivery of benefits to society especially in the following areas, recognized in the GEOSS 10-Year Implementation Plan: "Improving the management and protection of terrestrial, coastal, and marine ecosystems" [1].

In the framework of the HYPAD.COM, the integration of the EO hyperspectral data (airborne and ground-based) has been performed to improve the quality of the information available from EO data as well as to characterize the Albania and Montenegro coastal area and the surrounding lands.

For the purposes of the HYPAD.COM project, the following scientific objectives, for the coastal area, have been identified:
a) the characterization of the coastal water;
b) the detection of the coastal fresh water;
c) the spectral characterization of submerged aquatic vegetation [2].
The aims of the project devoted to characterize the surrounding land are:
d) the spectral characterization of vegetation/land use and land cover;
e) the spectral characterization of the bauxite refinery residues derived from aluminium production [3].

Methodology and results
The CNR (National Research Council) through the mediation of Italian Ministry for the Environment and Territory "Direzione Ambientale Ricerca e Sviluppo" has implemented cooperation with some Italian and foreign research agency for the success of the project. These agencies have shown great interest in and willingness for project activities, collaborating, constructively and proposing suggestions. The Albanian - Montenegrin coastal environments have been selected as study areas in accordance to the local Institutions requests.

On the basis of the scientific objectives and proposes defined in the project, several actions have been taken:
§ Three oceanographic cruises have been realized, in synergy with the Adricosm-star project [4], to spectrally characterize the water constituencies of the coastal waters along the Albanian and Montenegro shorelines. About 90 water column stations were caracterized [5];
§ June 2008, airborne hyperspectral MIVIS survey (53 flightiness) has been deployed on part of the Montenegro and Albanian coast and on the Buna/Bojana river;
§ July 2008 spectral signatures of the main submerged vegetation species were collected on Montenegro coastal with the objectives to map the submerged vegetation extension (e.g. *Posidonia oceanica*) and to analyze the impact of a growing urbanization of the coastline. About 40 sites were caracterized [3];
§ June-July 2008, field CAL/VAL campaigns were conducted along the surveyed area to define a spectral library of the main land cover units and on the more significant material in order to be applied in a spectral "data base" and to be integrated with the airborne survey.

Conclusions
The HYPAD.COM activities have been carried out within a close and continuing collaboration of the some Italian and foreign research agency. The results of the project have generated strongly interest to continue the scientific research with the involved Institutions.

In front of that, on the Joint Committee of the July 31, 2008 the Ministry of Environment of the Republic of Albania, Institute of Hydrometeorology of Albania e University of Tirana declared their formal declaration of interest to collaborate in the HYPAD.COM project at the Italian Ministry for the Environment and Territory, as the below minute states:

"Hypad.com (HYPerspectral for ADriatic COastal Monitoring).
Members of the Joint Committee agreed that, since involvement of the Albanian Institutions (MoEFWA; Institute of Energy, Water and Environment; Institute of Albanologi Studies) has been important in the definition of the monitoring activities and of the major environmental problems affecting the area, the possibility of involvement (onerous) of the above mentioned Albanian Institutions will be taken into consideration in the proposal of extension of the activities of this project".

References
1 - GEOSS, 2005. 10-Year Plan Reference Document. pp.209.
2 - Cavalli R.M., Kljaji Z., Macic V., Palombo A., Pascucci S., Pignatti S. and Santini F., 2009. Discrimination of phanerogams communities through spectral analysis: preliminary study of Montenegro coastal areas. Proceedings of ISRSE 33rd International Symposium on Remote Sensing of Environment, Sustaining the millennium development goals, Stresa, Italy.
3 - Pascucci S., Belviso C., Cavalli R. M., Laneve G., Misurovic A., Perrino C. and Pignatti S., 2009. Red mud soil contamination near an urban settlement analyzed by airborne hyperspectral remote sensing. IGARSS-09 Cape Town, 2009 IEEE International Geoscience and Remote Sensing Symposium, University of Cape Town, South Africa.
4 - Oddo P., Pinardi N. and Zavatarelli M., 2005. A numerical study of the interannual variability of the Adriatic Sea (2000–2002), *Sci. Tot. Environ*., 353: 39-56.
5 - Fargion G S. and Mueller J.L. (eds.), 2000. Ocean Optics Protocols for Satellite Ocean Color Sensor Validation: Revision 2, NASA Goddard Space Flight Center, Greenbelt, MD, USA

NUMERICAL MODELING OF THE SURFACE CIRCULATION IN THE SEA OF MARMARA DURING THE TSS EXPERIMENT (SEPTEMBER 2008 – MARCH 2009)

J. Chiggiato [1]*, S. Besiktepe [1], E. Jarosz [2], J. W. Book [2], L. Torrisi [3], P. Poulain [4] and R. Gerin [4]
[1] NATO Undersea Research Centre, La Spezia, Italy - chiggiato@nurc.nato.int
[2] Naval Research Laboratory - Stennis Space Centre, MS, USA
[3] Centro Nazionale di Meteorologia e Climatologia Aeronautica, Roma, Italy
[4] Istituto Nazionale di Oceanografia e Geofisica Sperimentale. Trieste, Italy

Abstract
ROMS and SWAN models are used to simulate and to exploit the Marmara Sea general circulation and the response to windstorms within the framework of the international scientific program "Turkish Straits System (TSS) 08-09". Model results show a general circulation in agreement with previous literature and the data collected as well as a remarkable impact of windstorms with complete reversal of the surface flow and frequent upwelling events.
Keywords: Marmara Sea, Currents, Circulation Models

Between August 2008 and March 2009, the international scientific program "Turkish Straits System (TSS) 08-09" was carried out under the coordination of the NATO Undersea Research Centre (NURC, La Spezia, Italy), jointly with the NRL project "Exchange Processes in Ocean Straits" (EPOS). During September 2008 and February 2009 the NR/V Alliance sampled extensively the Marmara Sea waters with the deployment of several different instruments (e.g., CTDs, moorings, bottom-mounted ADCPs and profilers, surface lagrangian drifters, Wave Raider, meteorological buoy etc.), some of them providing 1 to 6 months time-series of currents, tracers or meteorological conditions.

Several realistic numerical experiments of the Marmara Sea circulation have been carried out in order to understand the ongoing dynamics, providing simulations of the autumn-winter general circulation and the windstorm-induced circulation. The core ocean model used is the Regional Ocean Modeling System (ROMS, [1]), run uncoupled or coupled 2-way with the wave model SWAN [2]. The numerical grid (same for both models) covers the entire Marmara Sea, with two open boundaries located a few kilometers up strait in the Bosphorus and Dardanelles straits and a varying horizontal resolution of 500 – 1500 m. CTD data collected during the field trial either in late August 2008 or early February 2009 provide the initial field for the ocean model. Lateral boundary conditions are provided by NRL bottom-mounted ADCPs (momentum fluxes) while available moorings and CTDs provide temperature and salinity profiles in the straits. The non-hydrostatic, high-resolution (7 km in the horizontal) numerical weather prediction model COSMO-ME, run at the Italian national meteorological centre of the Italian air force provides surface boundary conditions for both ROMS and SWAN.

The general circulation derived using ROMS is in agreement with the general picture provided by [3], and fairly agrees with the observations collected. A major focus of this modeling exercise is to study the wind driven circulations in the Marmara Sea and model results show complete reversal of the upper layer flow depending on the sector of provenance of the wind storm. Westward (eastward) flow associated with north-easterlies (south-westerlies) also trigger upwelling/downwelling dynamics along the coastline of the Marmara Sea, with relevant storm-induced basin-wide oscillation of the mixed layer depth.

In addition, the 2-way coupled ROMS/SWAN model is used to simulate wave-current interactions in the area. Wave-current interactions are considered using the Mellor's equation for the inclusion of radiation stress and stokes drift in the momentum balance equation [4] and the inclusion of wave breaking as TKE injection as surface boundary condition of the Generic Length Scale turbulence model following [5]. The impact of wave current interactions is eventually assessed using skill scores based on surface lagrangian drifters.

References

1 - Shchepetkin A.F. and McWilliams J.C., 2005. The regional ocean modelling system: a split-explicit, free-surface, topography-following-coordinates ocean model. *Ocean Modell.*, 9: 347–404.
2 - Booij N., Ris R. C., and Holthuijsen L. H., 1999. A third-generation wave model for coastal regions, Part I, Model description and validation. *J. Geophys. Res.*, 104 (C4): 7649-7666.
3 - Besiktepe S.T., Sur H.I., .Ozsoy E., Latif M.A., Oguz T. and Unluata U., 1994. The circulation and hydrography of the Marmara Sea. *Prog. Oceanogr.*, 34: 285–334.
4 - Warner J.C., Sherwood C.R., Signell R.P., Harris C. and Arango H.G., 2008. Development of a three-dimensional, regional, coupled wave, current, and sediment-transport model. *Comput. Geosci.*, 34: 1284– 1306.
5 - Carniel S., Warner J.C., Chiggiato J., Sclavo M., 2009. Investigating the impact of surface wave breaking on modeling the trajectories of drifters in the northern Adriatic Sea during a wind-storm event. *Ocean Modell.*, 30: 225–239.

EFFECTS OF THE ADRIATIC-IONIAN BIMODAL OSCILLATING SYSTEM (BIOS) ON THE BIOGEOCHEMISTRY OF THE ADRIATIC SEA

Giuseppe Civitarese [1]*, Miroslav Gacic [1], Vanessa Cardin [1] and Gian Luca Eusebi Borzelli [2]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale-OGS, Trieste, Italy - gcivitarese@ogs.trieste.it
[2] Telespazio S.p.A., Rome, Italy

Abstract
The Adriatic-Ionian Bimodal Oscillating System (BiOS) is an internal mechanism capable to shape the thermohaline properties and the biogeochemical pool in the Southern Adriatic. The BiOS mechanism determines the upper-layer circulation (anticyclonic or cyclonic) in the Ionian Sea. Biogeochemically, the interfaces (i. e. the nutricline, and the oxygen minimum / nutrient maximum layer) at the border of the gyre in the northern Ionian are upwelled or downwelled depending on the circulation regime. This results in varying of the water characteristics advected northward through the Strait of Otranto, and the dynamics and the trophism of the Adriatic Sea.
Keywords: Adriatic Sea, Ionian Sea, Nutrients

Recently, the upper-layer circulation in the Ionian Sea has been associated with the deep thermohaline circulation [1] through a negative feedback mechanism [2], here called Adriatic-Ionian Bimodal Oscillating System (BiOS). In few words: the Ionian upper-layer circulation reverses from anticyclonic to cyclonic and viceversa (Fig. 1).

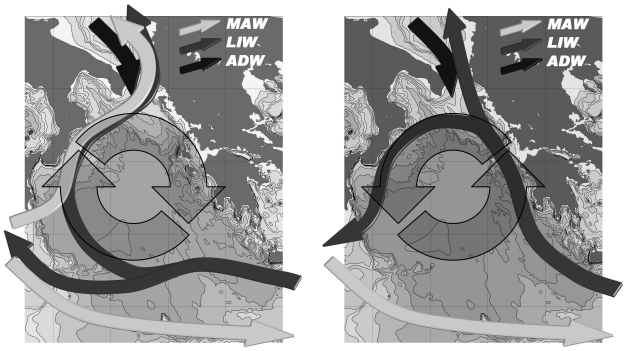


Fig. 1. Anticyclonic (left) and cyclonic (right) circulation modes and the consequent pathways of the major water masses according to the BiOS mechanism.

The anticyclonic circulation allows the modified Atlantic Water (AW) to enter the Adriatic, decreasing the average salinity there. In turn, the Adriatic produces and exports water with progressively lower density. Subsequently, the isopycnal surfaces along the pathway of the Adriatic Deep Water (AdDW) at the flanks of the Ionian deepen, the corresponding sea level increases, gradually weakening the anticyclonic upper-layer circulation and finally inverting the surface pressure gradient and the circulation from anticyclonic to cyclonic [2]. In turn, the cyclonic circulation favours the ingression of salty water of Levatine and/or Cretan origin, now no longer diluted by the presence of the AW. This increases the salinity in the Adriatic, lowering the sea level along the pathway of the exported water at the flanks of the Ionian, inverting the surface pressure gradient and finally re-establishing the upper anticyclonic circulation [2]. Due to the BiOS mechanism, the averaged thermohaline properties in the Southern Adriatic exhibit a quasi-periodic variability at a time-scale of about 10 years. The same behaviour, but with an opposite phase, is reported for the time series of averaged nitrate concentrations during the last 25 years (Fig. 2).

In this case, the decadal variability seems to be associated with the vertical displacement of the interfaces at the border of the Ionian gyre. The sequence of anticyclones and cyclones in the Ionian Sea causes a vertical oscillation of the nutricline and of the oxygen minimum/nutrient maximum layer, determining a significant variations of the biogeochemical averaged concentration of the portion of water column horizontally advected towards the Adriatic through the Strait of Otranto. The comparison of the long-term variations of nutrient concentrations in the Southern Adriatic and in the northeastern Ionian reveals that the two show coherent behaviour. Major differences in concentration values are reported for periods when strong winter convection occurs in the Southern Adriatic [3]. At the re-establishment of the stratification following the winter convective mixing, the nutrient in the enriched surface layer is consumed by the primary producers (phytoplankton). Satellite images clearly show the increase of biomass immediately after the stratification. Consequently, the nutrient pool is reduced as a function of the intensity and the number of convective events [3]. To conclude, we show that the Ionian upper-layer circulation has a great impact on the major water masses pathway and on the horizons of the biogeochemical interfaces. In turn, the Southern Adriatic represents a sensor for the Ionian circulation and for the state of the thermohaline cell of the Eastern Mediterranean. In this context, the intense activity of OGS and other Italian and Croatian institutions within the recent established Southern Adriatic Interdisciplinary Laboratory for Oceanographic Research (SAILOR) will be further implemented.

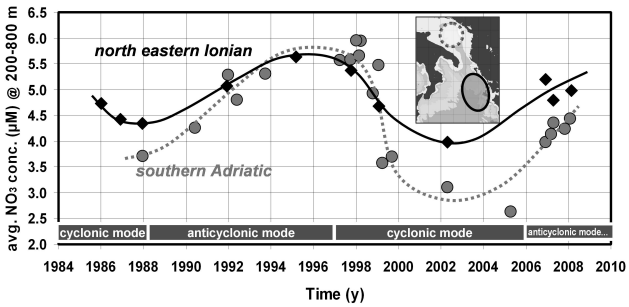


Fig. 2. Nitrate time-series in the southern Adriatic and northeastern Ionian averaged in the 200-800 m layer.

References
1 - Eusebi Borzelli G. L., Gacic M., Cardin V. and Civitarese G., 2009. Eastern Mediterranean Transient and reversal of the Ionian Sea circulation. *Geophys. Res. Lett.*, 36, doi:10.1029/2009GL039261.
2 - Gacic M., Eusebi Borzelli G. L., Civitarese G., Cardin V. and Yari S., 2009. Can internal processes sustain the reversal of the Ionian upper-layer circulation? Submitted to *Geophys. Res. Lett.*
3 - Civitarese G. and Gacic M., 2001. Had the Eastern Mediterranean Transient an Impact on the New Production in the Southern Adriatic? *Geophys. Res. Lett.*, 28(8): 1627-1630.

IMPACT OF HYDRODYNAMIC CHANGES ON MEDITERRANEAN BIOGEOCHEMICAL BUDGETS (WP1 OF THE MERMEX PROJECT)

Pascal Conan [1], Claude Estournel [2]* and Louis Prieur [3]
[1] Laboratoire d'Océanographie Biologique de Banyuls (LOBB), Université Paris VI, CNRS, Banyuls/Mer, France
[2] Laboratoire d'Aérologie, CNRS Université de Toulouse, Toulouse, France - Claude.Estournel@aero.obs-mip.fr
[3] Laboratoire d'Océanographie de Villefranche (LOV), Université Paris VI, CNRS, Villefranche/Mer, France

Abstract
The objectives of the MERMEX project focus on the understanding of the ecosystems response to likely changes in physical, chemical and socio-economical forcing induced by global change and by growing anthropogenic pressure. The objectives of MERMEX workpackage 1 are (i) to assess the budget of nutrients and of some contaminants, (ii) to understand their past and future evolution, and (iii) to understand the specific stoichiometry of inorganic and organic matter in the Mediterranean Sea.
Keywords: Geochemical Cycles, Nutrients, Western Mediterranean

The questions addressed by the workpackage 1 of MERMEX concern the evolution of biogenic elements and contaminants in the Mediterranean in relation with specific characteristics:
- a marked limitation of primary production by phosphorus,
- budgets of nitrogen and silica showing a deficit but based on non synoptic and sparse data,
- an increasing trend for phosphate and nitrate concentrations in deep water mainly in the western basin,
- an increase of anthropogenic input,
- a recent evolution of the stoichiometry of these imputs.

The strategy chosen to deal with this question is double: first, to establish budgets of nutrients and second, to understand their past and future evolution. This "budget" approach is complexified by the contrasted functioning of the different regions of the Mediterranean, from mesotrophy to ultra oligotrophy. It was then decided to divide the Med Sea in group of regions characterized by similar trophic regimes and to study for each regime a representative region of the group. The approach then consists to do a budget of standing crops of C, N, P in their mineral / organic, dissolved/particulate forms and to characterize their primary fluxes. These informations will then be used to calibrate and validate numerical models which are the only way to integrate the complex interactions between hydrodynamical, and bio-geochemical processes. Following the classification of [1], four typical trophic regimes have been identified: - the regions marked by a bloom in late winter-early spring months, - the "intermittently blooming"zones with erratic regimes alterning intense biomass accumulation and oligotrophic conditions, - the oligotrophic regions with higher and quite constant biomasses in fall-winter and lower and uniform values in late spring-summer, - the coastal regions characterized by a high biomass in winter and a more reduced biomass in spring.

In a first time, we want to implement our strategy on the northwestern Mediterranean representative of the first trophic regime cited above. This region is characterized by a pronounced spring bloom associated to upward transport of intermediate or deep water rich in nutrients. The HYMEREX experiment at the heart of our strategy will be based on three cruises in fall 2012, spring 2013 and fall 2013. These field cruises will be carried out in collaboration with the Hymex program, to have a synoptic view of the meteorological and hydrodynamical conditions in the whole area. Our aim is to reduce the uncertainties on the air-sea fluxes and on the volume and characteristics of dense water formed during winter each year, including the impact on the stocks, composition and quality of organic and mineral matter. For each of these cruises, an array of 280 stations will be visited in less than 35 days (figure 1) at which stocks of nutrients, organic matter, contaminants, biogenic fluxes (production mineralization) will be measured as well as temperature and salinity and meteorological fluxes. Biodiversity will also be considered. The modelling will be initialized from the first array. The boundary conditions will be constrained as often as possible by regular glider lines, and information from autonomous profilers and mooring lines. Specific experiments concerning key biological fluxes (hyperbaric bacterial production, grazing, …) not in accordance with a high frequency sampling strategy will be carried out in the same time on a second ship devoted to processes studies. Besides this experiment that should allow to improve our hydrodynamic and biogeochemical models, a long-term monitoring of the biogenic elements will be done by the MOOSE project with time series at fixed points, mooring lines, ARGO profilers and gliders equipped with bio sensors allowing to efficiently sample the water column. Finally, we hope to establish dialogue and collaboration with our colleagues of the different countries of the Mediterranean to have similar actions in other typical regions.

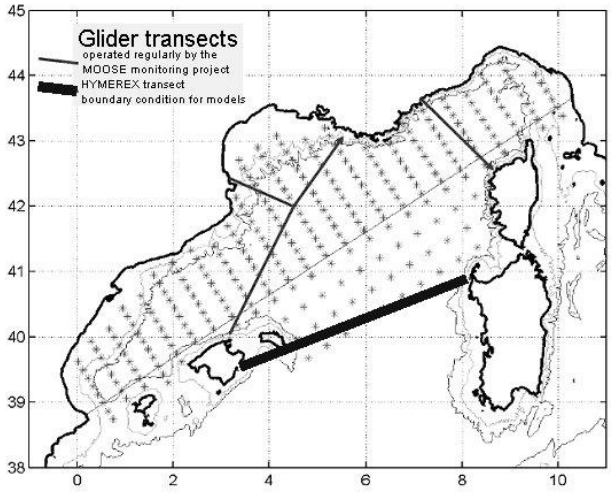


Fig. 1. Scheme of the HYMEREX cruises. The crosses correspond to CTD stations, black lines to gliders transects

References
1 - 1- D'Ortenzio, F. and Ribera d'Alcalà, M., 2009. On the trophic regimes of the Mediterranean Sea: a satellite analysis. *Biogeosciences*, 6 : 139-148.

SURFACE CURRENT DYNAMICS IN THE NORTH EASTERN ADRIATIC SEA FROM HIGH-FREQUENCY RADAR OBSERVATIONS AND HIGH-RESOLUTION WIND FIELDS

Simone Cosoli [1]*, Miroslav Gacic [1] and Andrea Mazzoldi [2]
[1] Istituto Nazionale di Oceanografia e Geofisica Sperimentale, Trieste, Italy - scosoli@ogs.trieste.it
[2] Istituto di Scienze Marine - CNR, Venezia, Italy

Abstract
The dominant processes governing the circulation in a 40 km x 60 km area off the Italian coast and the Istrian peninsula, Northern Adriatic Sea, are assessed using surface current measurements from high-frequency radars and high resolution wind fields for the period September 2007 – August 2008. Time-averaged currents are weak and reveal a cyclonic circulation pattern with intensification in the northern sector (Fig.1). Vorticity is prevalently positive and related either to current shear or current rotation. The flow in the region is primarily driven by winds, which impart vorticity to the current fields, whereas tidal oscillations within the diurnal and semidiurnal frequency bands have a minor role in the circulation.
Keywords: Tides, Remote Sensing, Circulation, Adriatic Sea

High frequency observations of surface currents in the Northeastern Adriatic Sea for the period September 2007 – August 2008 reveal a cyclonic circulation scheme with weaker currents in the southern part of the domain, and an intensification along the Italian coast to the North where water is shallower and wind influence is stronger (Fig. 1).

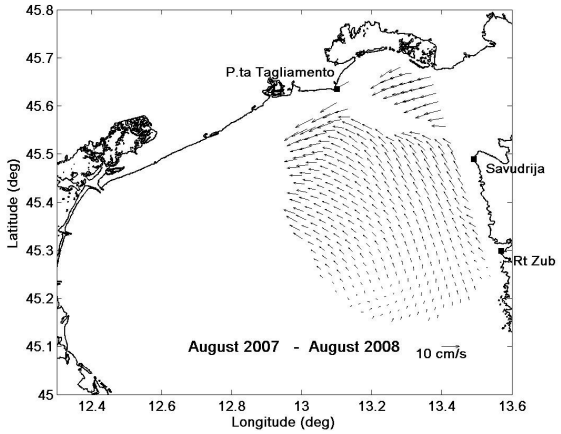


Fig. 1. Time-averaged surface flow pattern in the investigated area (Northern Adriatic Sea) as derived from High-Frequency radar observations for the period August 2007 - August 2008

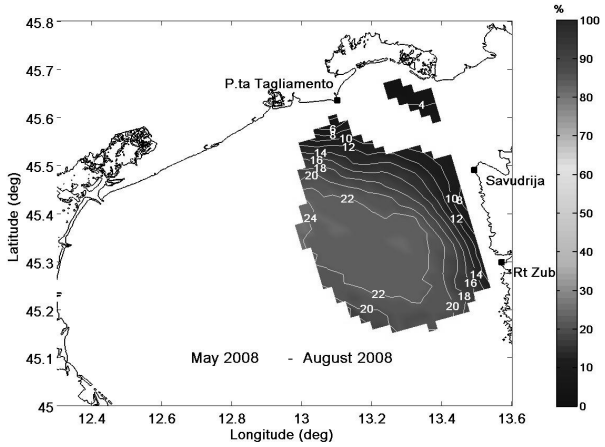


Fig. 2. Percent ratio between inertial current variance and non-tidal current variance for summer (May 2008 - August 2008) season

Tides are weak, and represent a small fraction of the overall flow variance. High-frequency non tidal oscillations (inertial oscillations; diurnal-period wind-driven currents) have different patterns in time and space. Both inertial motions and non-tidal diurnal-period oscillations increase their contribution during spring and summer seasons, when the water column is stratified (Fig. 2).

An opposite trend in variance distribution characterize these high-frequency motions, with diurnal-period currents having their maximum variance in the Northern part towards the Italian coast and the Trieste Gulf entrance, and inertial oscillations showing their maxima towards the centre of the Northern Adriatic basin.

Current vorticity is prevalently positive and related either to current shear to the North, or to current rotation to the South. Wind stress curl is the major source of surface flow vorticity for time scales longer than the local inertial period. For these time scales wind stress curl is balanced by an increased surface flow divergence.

The dominant wind regimes in the area, namely the bora and the scirocco winds, drive two different current patterns. Bora enhances the coastal jet along the Italian coast and introduces a strong cyclonic recirculation in the southern area. Scirocco on the other hand homogenizes the flow pattern and forms small-scales eddies along the Italian coastline in the Northern sector.

References
1 - Gacic M., Kovaceviv V., Cosoli S., Mazzoldi A., Paduan J.D., Mancero-Mosquera I. and Yari S., 2009. Surface current patterns in front of the Venice Lagoon. *Estuar. Coast. Shelf S.*, 82: 485-494
2 - Kovacevic V., Gacic M., Mancero-Mosquera I., Mazzoldi A., and Marinetti S., 2004. HF radar observations in the northern Adriatic: surface current field in front of the Venetian Lagoon. *J. Mar. Syst.*, 51: 95 – 122

FLUXES OF ^{137}CS IN THE SYSTEM BLACK – MARMARA - NORTH AEGEAN SEAS

R. Delfanti [1]*, E. Ozsoy [2], E. Kaberi [3], A. Schirone [1], S. Salvi [4], F. Conte [1], C. Tsabaris [3] and C. Papucci [5]
[1] ENEA, Marine Environment Research Centre, La Spezia, Italy - roberta.delfanti@enea.it
[2] Hellenic Centre for Marine Research, Anavissos, Greece
[3] Institute of Marine Sciences, Middle East Technical University, Erdemly, Turkey
[4] ENEA, Research Centre Brasimone, Camugnano, Italy
[5] ENEA, Marine Environment Research Centre/ CNR, Institute of Marine Sciences, La Spezia, Italy

Abstract
The inventory of ^{137}Cs in the Western Black Sea at 2000 m water depth is presently 3.4 kBq m^{-2}, not significantly different from that measured in 1988, but about 1 kBq m^{-2} was transferred from the surface layer to the depth interval 100-400 m. 12 TBq y^{-1} of ^{137}Cs leave the Black Sea in the surface layer through the Bosphorous and only 2 TBq y^{-1} are brought back in association with the Mediterranean water from the Marmara Sea. The most important mechanism transferring ^{137}Cs and dissolved contaminants from surface Black Sea to the sub-picnoclyne layer is mixing on the southwestern shelf, at the exit from Bosphorous, between Mediterranean Water and surface water, producing an extra export of some10 TBq y^{-1} of ^{137}Cs from the surface layer.
Keywords: Black Sea, Marmara Sea, Radionuclides

Introduction and objectives
Due to the intense direct Chernobyl fallout and to the delayed input from rivers, the Black Sea has become a point source of radionuclides to the Mediterranean Sea. Some of these, like the long lived ^{137}Cs, are still easily detectable in the Black Sea and traceable along their pathway in the North Aegean Sea. The determination of the spatial distribution of ^{137}Cs in the system Black – Marmara – N. Aegean Sea can greatly help in elucidating the exchanges of dissolved contaminants among the basins and the role of the Turkish Straits System (TSS) in the contaminants budget of the Black Sea.

Study area
In the Black Sea freshwater input from large rivers (Danube, Dniepr, Dniestr and Don) and precipitation largely exceed loss by evaporation.The density-driven two-layer exchange flow through the Straits carries the excess of Black Sea Water to the Mediterranean and the saline Mediterranean water first to the Marmara Sea and then to Black Sea. This hydrological balance supports a stable environment, with two main components: colder, fresher, surface waters overlying warmer, more saline deep waters, separated by a permanent pycnocline [1, 2]. In May 2007 seawater samples were collected by IMS-METU in the different water masses of two of the three deep basins of the Marmara and in the Western Black Sea for the characterization of present ^{137}Cs vertical profiles and for a first estimate of the fluxes of the radionuclide in the TSS. We also present here the ^{137}Cs vertical profiles measured in 2001 in the N. Aegean Sea, to characterize the input of the radionuclide to the TSS in the Mediterranean Water flow (Fig. 1).

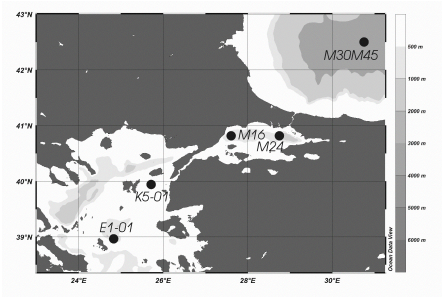


Fig. 1. Study area and sampling sites.

Results
In the Black Sea, surface concentrations are about 20 Bq m^{-3} and, decreasing almost exponentially, reach a constant value of 0.7 Bq m^{-3} at a depth of 600 m. Comparing this profile with that obtained in 1988 in a nearby station [3], ^{137}Cs concentration below the halocline has significantly increased, while the levels in surface water are less than a half of what expected from physical decay only. The inventories have not significantly changed: 2.9 kBq m^{-2} in 1988 (decay corrected to 2007) and 3,4 kBq m^{-2} in 2007. The increase at depth below the halocline, in this deep-sea area, compensates the loss at the surface. In the Marmara Sea surface concentrations are about 15 Bq m^{-3}, decreasing to about 4 Bq m^{-3} in the underlying Mediterranean water. The ^{137}Cs concentration in the Mediterranean Water entering the Dardanelles was assumed to be 3.5 Bq m^{-3}, mean value of the ^{137}Cs concentrations in the depth interval 50-300 of the N. Aegean Sea, corrected for physical decay to 2007. Based on ^{137}Cs concentrations in the different water masses and on volume fluxes estimated by Besiktepe et al. [2] we have estimated the fluxes of the radionuclide in the Turkish Straits System (Fig. 2).

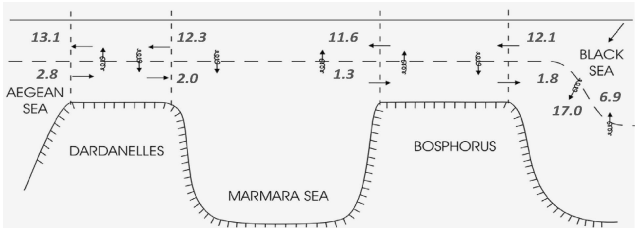


Fig. 2. Mean annual fluxes of ^{137}Cs (10^{12} Bq y^{-1}) in the TSS.

Conclusions
In the Western Black Sea, at 2000 m water depth, about 1 kBq m^{-2} of ^{137}Cs was transferred from the surface layer to 100-400 m in the period 1988 - 2007. Presently about 12 TBq y^{-1} of ^{137}Cs leave the Black Sea in the surface layer through the Bosphorous and only 2 TBq y^{-1} are brought back with the Mediterranean water from the Marmara Sea, resulting in a net annual loss of 10 TBq y^{-1}. The inflow of Mediterranean water alone does not explain the increase of ^{137}Cs concentration and inventory at intermediate depth in the Western Black Sea. The most important mechanism transferring ^{137}Cs and dissolved contaminants from surface water to the sub-picnoclyne layer appears to be the mixing on the southwestern shelf, at the exit from Bosphorous, between inflowing Mediterranean Water and Black Sea surface water. This process produces an extra export of some10 TBq y^{-1} of ^{137}Cs from the surface layer. It is the advection of this water towards the Black Sea deeper layer (200-600 m) that maintained the inventory constant with time.

Aknowledgements
This study has been partly funded by the EU 6th FP project SESAME (contract no. 036949-2).

References
1 - Özsoy E. and Ünlüata Ü., 1997. Oceanography of the Black Sea: a review of some recent results. *Earth-Sci. Rev.*, 42: 231-272.
2 - Besiktepe S., Sur H., Özsoy. E., Latif M.A., Oguz T. and Ünlüata. Ü., 1994. The circulation and hydrography of the Marmara Sea. *Prog. Oceanog.*, 34: 285-334.
3 - Buesseler. K.O., Livingston. H.D. and Casso. S., 1991. Mixing between oxic and anoxic waters of the Black Sea as traced by Chernobyl cesium isotopes. *Deep-Sea Res.*, 38: S725-S745.

A FIVE-YEAR BUDGET OF FINE SEDIMENT IN THE GULF OF LIONS: IMPORTANCE OF INTENSE EVENTS (FLOODS, STORMS AND DENSE WATER CASCADING)

C. Estournel [1]*, C. Ulses [1], X. Durrieu De Madron [2], P. Puig [3] and P. Marsaleix [1]
[1] Laboratoire d'Aérologie, CNRS, University of Toulouse, Toulouse, France - claude.estournel@aero.obs-mip.fr
[2] CEFREM, CNRS and University of Perpignan, Perpignan, France
[3] Institut de Ciencies del Mar, CSIC, Barcelona, Spain

Abstract
A sediment transport model has been applied to the Gulf of Lions to estimate the budget of fine particles over the period running from December 2003 to December 2008. The consequences of the succession of intense events are examined in terms of sedimentation and resuspension on the different parts of the shelf, and export toward the slope and the deep basin.
Keywords: Coastal Models, Continental Shelf, Sediment Transport, Western Mediterranean

A modelling approach [1] was used to study during a 6-month period in 2003-2004 the effect of marine storms and high rivers discharge on the fate of fine sediment in the Gulf of Lions. This study was extended to a period of 5 years including a variety of hydrologic and hydrodynamic conditions characteristic of the region including an exceptional flood of the different rivers of the Gulf, two severe winters and a few storms associated to moderate to high waves. Thanks to the monitoring of currents, temperature and turbidity performed on the Gulf of Lions slope during several crucial periods [2, 3], the model was first calibrated and validated. The main transport events are satisfactorily simulated. As both velocity and suspended matter concentration are well represented at the moorings localized in the canyon known as the main conduit from the shelf to the slope, the export given by the model is considered as robust. The duration of the simulation (5 yrs) allows to better understand the different mechanisms affecting the fate of fine particles. First the role of the Rhone prodelta on the storage of the river-borne particles, the effect of storms to transport sediment from east to west and the dense water cascading flushing the matter in the canyons of the western part of the Gulf. The role of bioturbation to renew the stock of fine particles in the surface sediment after a storm is also shown. The model is used to integrate the effect of these different mechanisms and to estimate the time constants associated to the transport along the river mouth, shelf, slope and deep sea continuum. A sediment budget of the different parts of the shelf and slope is shown on Figure 1.

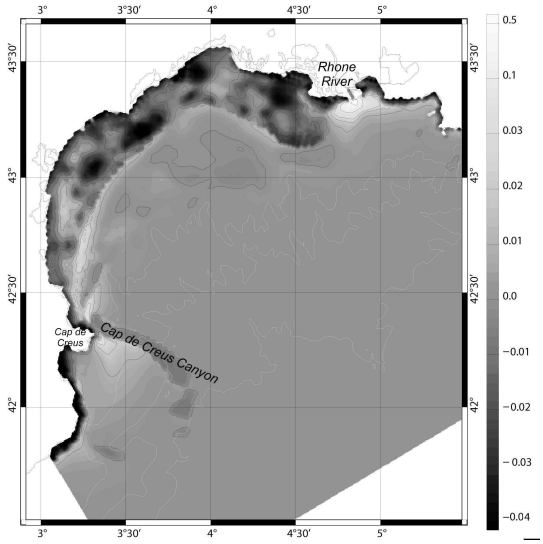


Fig. 1. Sediment budget of the December 2003-December 2008 period in meter. Positive value correspond to deposition, negative values to erosion. White isocontours indicate the 200, 1000 and 2000m isobaths.

Dark colors indicate mean erosion, light colors indicate accumulation. The Rhône prodelta accumulates a large part of the continental particulate input to the Gulf of Lion. Erosion is mainly confined on the inner shelf but the Cap de Creus canyon was also eroded due to the strong currents associated to the dense water cascading of winters 2005 and 2006. The exportation off the Gulf of Lion shelf has been estimated to lie between 20 and 30 Millions of tons in 5 years. The region of the Cap de Creus is the main pathway for this export. The role of the Cap de Creus canyon is particularly important as it is able to stock after a storm large amounts of matter which can be later flushed by dense water cascading. The affinity of heavy metals with fine particles allows us to give a first estimation of the remobilization of these contaminants by intense events.

References
1 - Ulses C., Estournel C., Durrieu de Madron X., Palanques A., 2008. Suspended sediment transport in the Gulf of Lions (NW Mediterranean): Impact of extreme storms and floods. *Cont. Shelf Res.*, 28: 2048-2070.
2 - Palanques A., Durrieu de Madron X., Puig P., Fabres J., Guillen J., Calafat A., Canals M., Bonnin J., 2006. Suspended sediment fluxes and transport processes in the Gulf of Lions submarine canyons. The role of storms and dense water cascading. *Marine Geol.*, 234: 41–63.
3 - Puig P., Palanques A., Orange D.L., Lastras G., Canals M., 2008. Dense shelf water cascades and sedimentary furrow formation in the Cap de Creus Canyon, northwestern Mediterranean Sea. *Cont. Shelf Res.*, 28: 2017-2030.

WATER MASS STRUCTURE AND ASSOCIATED PROCESSES IN THE TYRRHENIAN SEA (SOUTHERN SECTOR) BY MEANS OF IN SITU DATA COLLECTED DURING VECTOR-TM CRUISES

Pierpaolo Falco [1]* and Enrico Zambianchi [1]

[1] Dipartimento di Scienze per l'Ambiente, Università degli Studi di Napoli "Parthenope" Centro Direzionale, Isola C4 80143 Napoli, Italy - pierpaolo.falco@uniparthenope.it

Abstract

In this work we will present the results obtained from the analysis of hydrological data collected during 5 oceanographic cruises carried out in the southern sector of the Tyrrhenian Sea. Details regarding the vertical structure and associated processes of the water column are presented, together with information regarding deep current and temperature data obtained from a mooring located approximately in the centre of the southern Tyrrhenian basin

Keywords: Tyrrhenian Se, Hydrology, Deep Waters, Deep Sea Processes

In the framework of VECTOR (**V**uln**E**rability of the Italian coastal area and marine Ecosystems to **C**limatic changes and **T**heir r**O**le in the Mediterranean ca**R**bon cycles) project, starting at the end of November 2006, six oceanographic cruises were carried out in the area, centered on the so-called VTM station (see Fig.1, which also shows the CTD stations regularly sampled during the cruises as well as the position of the mooring), selected as a test site to study the seasonal and interannual variability of the intermediate and deep hydrology and dynamics of the Tyrrhenian Sea. The VTM point depth is approximately 3450 m, its coordinates are 39°30' N, 13°30' E, approximately 90 nautical miles off the Italian coasts. The oceanographic cruises were carried out in different seasons even if three of the six were conducted in a winter month. Thus, in terms of interannual variability, information could be derived only for the winter season. The remaining three campaigns were in Fall (late November 2006), early and late Spring (April 2007 and first third of June 2008 respectively).

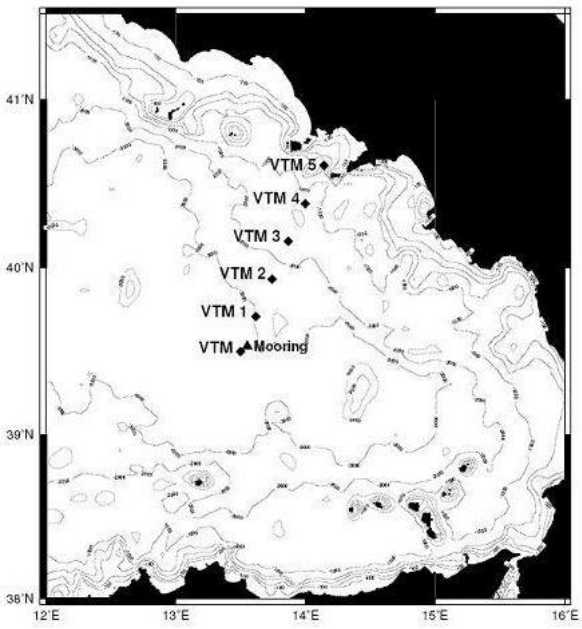


Fig. 1. Map of the stations sampled during VECTOR-TM cruises. Diamonds indicate CTD stations positions, whereas the triangle is the mooring

Moreover, on April 2007, a mooring was deployed very close (less than 1 nautical mile) to the point VECTOR-TM and worked up to January 2009. Current measurements at the depths of 1000, 1600 and 2200 meters, collected by means of Aanderaa RCM-9 currentmeters, are available for the period June 2007 –December 2007, whereas a yearly temperature time series (February 2008 – January 2009) at a depth of about 3430 meters is available too.

Information derived from this composite data set addressed three main issues: vertical structure of the investigated transect; thermoaline processes along the vertical, especially in the farthest offshore stations of the transect; intermediate and deep current patterns obtained from mooring time series.

The analysis of the collected CTD data allows identifying the three major water masses present in the basin: Atlantic Water (AW), Levantine Intermediate Water (LIW) and Tyrrhenian Deep Water (TDW). In particular, the vertical distribution of temperature and salinity of the upper layer, together with the relative geostrophic velocity field, pointed out that the overall circulation is broadly anticyclonic, as expected. If looked at from the perspective of long term change the data reveal several points of interest: for instance, bottom temperature and salinity values result slightly higher than in the past [1]; at the same time, the observed salinity maximum relative to the LIW is higher than in historical data (Fig. 2).

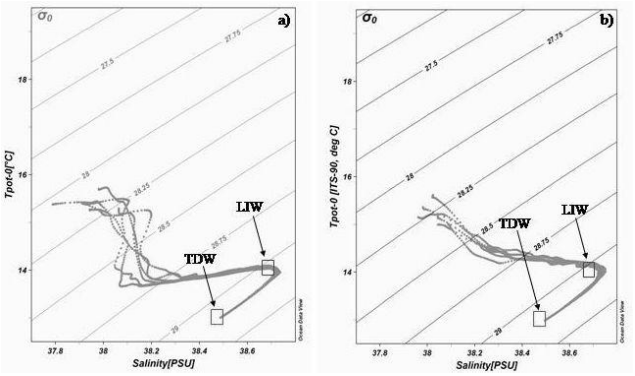


Fig. 2. Theta-S diagrams for the cruises VECTOR-TM 2 (a) and 6 (b). The two squares indicate the range of LIW and TDW as defined in [2].

The central Tyrrhenian is notoriously an area where double diffusive processes can be observed [2]. Thermohaline staircase structures have been found in all cruises, and characterized in terms of a number of parameters classically utilized for this purpose [3]. The stability of double diffusive structures in space and time (e.g., in terms of depth, width, gradient) is remarkable. Their associated temperature and salinity fluxes result stronger than in the past, and would deserve further investigations, prolonged in time.

Current data obtained from the mooring shows a relative strong W-NW flow with velocity values up to 10 cm/s at 1000 m whereas, as expected, the velocity slows down to few cm/s at deeper depths where the remaing two currentmeter were located. The direction is less stable with respect to the 1000 m currentmeter data but the net displacement is northwestward as well. Also, a diurnal tide signal can be observed from the spectral analysis of the deepest currentmeters whereas it does not appear in the 1000 m depth current measurement.

References

1 - Astraldi M. and Gasparini G.P., 1994. The seasonal Characteristics of the Circulation in the Tyrrhenian Sea, 1994, *In :* La Violette P.E. (ed.), Seasonal and Interannual Variability of the Western Mediterranean Sea, *Coastal and Estuarine Studies*, AGU, Washington D.C., 46: 115-134

2 - Zodiatis G. and Gasparinin G.P., 1996. Thermohaline staircase formations in the Tyrrhenian Sea. *Deep-Sea Res. I*, 43(5): 655-678

3 - Zhurbas V.M. and Ozmidov, R.V. 1984. Forms of step like structure of the oceanic thermocline and their generation mechanisms. *Oceanology*, 24: 153-157

RETRIEVING OCEAN SALINITY FROM SMOS MICROWAVE RADIOMETRIC MEASUREMENTS

Jordi Font [1]*
[1] Institut de Ciències del Mar CSIC, Barcelona, Spain - jfont@icm.csic.es

Abstract
SMOS (Soil Moisture and Ocean Salinity) is an Earth observation satellite from the European Space Agency launched in November 2009. It is the first satellite mission addressing the challenge of measuring sea surface salinity, never attempted before due to its technical complexity. It uses a microwave interferometric radiometer with aperture synthesis that generates brightness temperature images at 1.4 GHz, from which both geophysical variables are derived using their influence on the dielectric constant of the emitting body, land or ocean. This paper presents the principles of operation of the instrument, the algorithmic approach implemented for the retrieval of salinity from the observations, and the limitations for the use of SMOS products in the Mediterranean Sea.
Keywords: Salinity, Remote Sensing, Surface Waters, Open Sea

In 1999 the European Space Agency (ESA) selected the proposal of a mission to provide for the first time a global and continuous coverage of Soil Moisture and Ocean Salinity with resolution and accuracy adequate for climatic studies and large scale oceanography, as both variables play a key role in the control of the Earth's water cycle and as a consequence in the understanding of the possible climate evolution in the present context of global warming [1]. SMOS (http://www.esa.int/esaLP/LPsmos.html) was launched on November 2, 2009 and is expected to become operational by May 2010.

The measurement principle

All bodies emit electromagnetic radiation in a large range of wavelengths. At low frequencies, including microwaves, the brightness temperature of the body (T_B, the quantity to be measured by a radiometer, and related to the emitted power) is proportional to its physical temperature. The proportionality coefficient, the emissivity, is a function, among other variables, of the dielectric constant and as a consequence of the conductivity, and hence salinity when the emitting body is seawater. For SMOS a frequency of 1.4 GHz was selected, as it is close to the maximum sensitivity of T_B to changes in salinity as well as minimises the impact of other parameters influencing it. In addition, this is a frequency band where human made emissions are forbidden, so the risk of interferences should not be an issue. At this frequency the penetration of the radiation, and then the thickness of the emitting surface layer, is around 1 cm.

The fundamentals of salinity and soil moisture determination by microwave radiometry were sufficiently known, but no satellite mission had been attempted so far to measure these variables. The main reason was that to achieve a reasonable spatial resolution at this low frequency very large scanning antennas were needed, something that appeared not feasible on board a satellite. The solution implemented in SMOS is the use of a large number of small fully polarimetric antennas (up to 69, 20 cm diameter) deployed along three 4 m arms forming a Y shape. Instead of using the T_B recorded by the individual antennas, SMOS takes the correlation of the polarised signals from all pairs of antennas to reconstruct a unique T_B image through a complex process based on interferometry [2]. The result, in the selected configuration (758 km height, antenna plane 32.5º from horizontal), is a curved-hexagonal field of view, almost 1000 km wide, formed by pixels from 30 to 100 km, with varying incidence angle and radiometric resolution.



Fig. 1. The 69 antennas along the SMOS arms (by P. Carril for ESA)

Retrieving salinity values

The approach to determine the salinity of the ocean surface imaged at each SMOS overpass is based on a convergence loop that compares the measured T_B to the T_B theoretically emitted by the surface following a forward model of the ocean emission taking into account the seawater conditions. During the convergence the sea surface salinity (SSS) value is modified from a first guess until reaching an optimal fit with the measured T_B value. The geometrical optics theory provides a model of the flat sea emission, which depends on the temperature, salinity, angle of observation, frequency and polarisation state of the radiation. On top of this we have to introduce the effect of the sea roughness, as the topography of the emitting surface has a strong impact on the viewing geometry and then on the T_B measured by the radiometer. Further modifications are needed before comparing modelled and measured T_B, as the emitted radiation is modified in its path from the surface to the satellite (attenuation by the atmosphere, polarisation mixing in the ionosphere, …), while it is necessary to take into account other sources of radiation at the same frequency that can also reach the radiometer (emission by the atmosphere, galactic radiation scattered on the surface, …). The result is a quite complex algorithm implemented in the SMOS salinity processor [3].

Even the multiangular measurement characteristics allow for a redundant determination of SSS, the noise and other possible errors due to the instrument performance limitations, image reconstruction process, errors on external parameters needed to estimate the sea surface state (provided by numerical weather forecasts), and incomplete forward model formulation are expected to result in an accuracy in retrieved salinity around 1.5. To reduce this noise and reach the mission objectives, further processing is planned to generate global salinity maps by integrating several SMOS orbits in a temporal window of 10-30 days and spatial resolution of 100-200 km, then providing a product similar to present climatologies but including the temporal evolution. The goal is to achieve salinity accuracy close to 0.1.

These spatio-temporal characteristics of the SMOS observations, together with the fact that strong contamination from land radiation is expected in the first 100-200 km from coast, makes the use of these products in the Mediterranean Sea a real challenge. Some validation activities are planned within the Mediterranean Operational Oceanography Network (MOON, http://www.moon-oceanforecasting.eu/) to explore this limitation.

The development of SMOS has been a collective effort coordinated by ESA of many scientists and technologists as well as industrial companies from several countries, especially Spain and France. This paper is a contribution to the SMOS Barcelona Expert Centre and project ESP2007-65667-C04 funded by the Spanish Ministry of Science and Innovation.

References

1 - Drinkwater M., Kerr Y.H., Font J. and Berger M., 2009. Exploring the water cycle of the blue planet. The Soil Moisture and Ocean Salinity mission. *ESA Bull-Eur Space*, 137: 6-15

2 - Font J., Camps A., Borges A., Martín-Neira M., Boutin J., Reul N., Kerr Y.H., Hahne A. and Mecklenburg S., 2009. SMOS: The challenging measurement of sea surface salinity from space. *P. IEEE*, in press

3 - Zine S., Boutin J., Font J., N. Reul N., Waldteufel P., C. Gabarró C., Tenerelli J., Petitcolin F., Vergely J.L., Talone M., and Delwart S., 2008. Overview of the SMOS sea surface salinity prototype processor. *IEEE T. Geosci. Remote*, 46: 621-645

SURFACE CIRCULATION IN THE MARMARA SEA

Riccardo Gerin [1]*, Pierre-Marie Poulain [1], Sukru Besiktepe [2] and Pietro Zanasca [2]
[1] OGS-Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy - rgerin@inogs.it
[2] NATO Undersea Research Centre, La Spezia, Italy

Abstract
We study the surface circulation of the Marmara Sea over about one year using CODE drifters. The pseudo-Eulerian statistics were computed using the whole dataset and in terms of deployment episodes and major wind regimes.
Keywords: Circulation Experiments, Marmara Sea, Surface Waters

The Marmara Sea is a small (70 km x 250 km) semi-enclosed sea connecting the Mediterranean to the Aegean (through the Dardanelles Strait) and to the Black Sea (through the Bosphorus Strait). It has a complex topography characterized by three deep sub-basins each greater than 1000m in depth separated by deep sills and is connected to the straits through canyons. Here, complex processes of two-way exchange flows, jets, eddies and gyres occur [1].

As part of the Turkish Straits System (TSS) experiment, the surface circulation dynamics of the neighboring Black, Marmara and Aegean Seas was studied at scales from inertial/tidal to seasonal using low-cost CODE Lagrangian drifters [2] over about a year (from September 2008 to May 2009). Particular focus was given to the Marmara Sea that was seeded in two seasonal episodes (September 2008 and February 2009). About 30 drifters were deployed in key locations to maximize the geographical coverage and mainly in small (1 nautical mile) clusters of three drifters.

In addition to the standard positioning and data telemetry (SST, battery) provided by the Argos Data Collection and Location System (DCLS) onboard polar-orbiting NOAA satellites (with 300-1000 m position accuracy and about every 100 min), the drifters were equipped with GPS receivers to have a better determination of their position (with less than 10 m of uncertainty) and more frequently (every 30 min).

On the whole, the drifters sampled adequately the Marmara Sea (Fig.1), but the southern part was covered by drifters mainly during the first experiment (September deployments) and the northern part mainly during the second one (February deployments). The lifetime of the drifters in the Marmara Sea is very low due to the recovery by seafarers and stranding (it span from a few days to 50 days) and the mean half lifetime is only 13 days.

The combined raw Argos and GPS positions were edited for outliers and spikes using statistical and manual techniques [3] and were interpolated at regular 2-hours intervals. Surface velocity were calculated by central finite differencing the interpolated positions.

The Pseudo-Eulerian statistics (mean flow, variance ellipses, MKE and EKE) were calculated [4, 5] using a spatial averaging scale of 0.1° x 0.1° overlapped bins for the whole dataset, for the two deployment episodes and for different wind regimes.

The map of the mean surface flow using the whole dataset (Fig. 2) shows two eddies located in the northern part of the sea which extend for about 30 km and reach the middle of the Marmara Sea (the western feature is anticyclonic and the eastern one is cyclonic). South of these large features, a flow of about 20 cm/s joins the Bosphorus to the Dardanelles and another cyclonic eddy is evident in the southeastern area of the Marmara Sea.

The TSS drifter data were included in the MedSVP (Mediterranean Surface Velocity Program) database (http://nettuno.ogs.trieste.it/sire/medsvp/) and will be used to deepen our understanding of the surface dynamics of the Mediterranean and Black Seas.

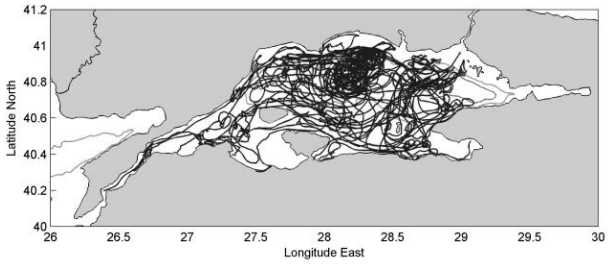


Fig. 1. Drifter spaghetti diagram in the Marmara Sea.

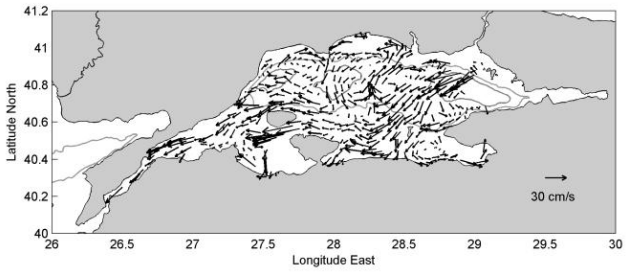


Fig. 2. Mean surface circulation in the Marmara Sea. The mean flow arrows are centred at the centre of mass of the observations in each bin. Data are grouped into 0.1° x 0.1° bins overlapped by 50%. Results for bins with less than 5 observations are not plotted.

References
1 - Besiktepe S.T., Sur H.I., Özsoy E., Abdul Latif M., Oguz T. and Ünlulata Ü., 1994. The circulation and hydrography of the Marmara Sea. *Prog. Oceanog*., 34: 285-334.
2 - Davis R.E., 1985. Drifter Observations of Coastal Surface Currents During CODE: The Method and Descriptive View. *J. Geophys. Res*., 90: 4741-4755.
3 - Poulain P.-M., Barbanti R., Cecco R., Fayes C., Mauri E., Ursella L. and Zanasca P., 2004. Mediterranean surface drifter database: 2 June 1986 to 11 November 1999. Rel. 75/2004/OGA/31, OGS, Trieste, Italy.
4 - Poulain P.-M., 2001. Adriatic Sea surface circulation as derived from drifter data between 1990 and 1999. *J. Marine Syst*., 29: 3-32.
5 - Emery W.J. and Thomson R.E., 2004. Data Analysis Methods in Physical Oceanography. Elsevier, Amsterdam. 638 pp.

ASSESMENT OF POST-TRANSIENT CHANGES IN LEVANTINE BASIN DEEP WATERS

Isaac Gertman [1]*, Barak Herut [1] and Nurit Kress [1]
[1] Israel Oceanographic & Limnological Research, Haifa, Israel - isaac@ocean.org.il

Abstract

Large deep water (DW) renewal in the Levantine Basin (LB) by dense water from the Cretan Basin started at about 1989 after massive advection of salty Levantine Surface Water in the Aegean Sea. An apogee of the DW outflow to the LB was observed in 1993 after the abnormally cold winters of 1992-1993. A relatively salty and warm water propagated above the sea bottom from the Cretan Passage with a rate of about 280 km/year. The DW renewal was first recorded near the south eastern continental slope of the LB in 1996. During 2001, the LB DW was quite homogeneous east of 25E. According to observations during 2008, a new DW mass spreads eastwards in the LB. This new water, originating from the Adriatic Sea, has higher potential density than the Cretan origin DW and the pre 1989 Adriatic DW.

Keywords: Deep Waters, Levantine Basin

A comprehensive analysis of Levantine Basin deep water evolution during the Eastern Mediterranean Transient (EMT) [1] brought a vivid picture of Cretan dense water cascading through the Cretan Arc straits and spreading in the Eastern Mediterranean intermediate and particularly bottom layers. Advection of abnormally saline Levantine Surface Water in the Aegean Sea during 1989-1990 [2] followed by extremely cold winters 1992-1993 [3] forced the formation of deep water with potential (relative 2000 db) density anomaly (σ_2) of about 37.83 kg/m^3 [1]. The excess over the pre EMT bottom water density was just 0.03 kg/m^3. However it was enough to generate a wide spreading of newly formed water. In 1995, three years after the apogee of dense water outflow from the Cretan Basin, the Levantine Deep Water below 2000 m had a stable inversion layer both in salinity and potential temperature. According to a long term series of Israeli observations on station h5 located near the continental slope of the south-eastern Mediterranean shelf (33.0°N, 34.5°E) the first evidence of such inversion was found in 1996. A coarse estimation of propagation rate of dense water from Cretan Passage to the south-eastern continental slope was about 280 km per year. Before the EMT influence, the h5 station's water at depth of 1400 m had salinity 38.68±0.02 with a negative vertical gradient of about 0.005 per 100 meters. Potential temperature was 13.37±0.02°C with a decrease rate of 0.015°C per 100 meters. During the period 1996 – 2002, salinity and potential temperature increased monotonically reaching 38.77, 13.59°C and changing the vertical gradients signs.

Relatively regular observations in the framework of Israel's national project "Haifa Section" from 2002 to 2009 show fluctuations in salinity and potential temperature with ranges of 0.02 and 0.02°C respectively. Observations from R/V "Meteor" during 2001 [1] revealed quite homogeneous water for regions east of 25°E and deeper than 2000 m (38.82±0.02, 13.71±0.02°C). However on the most western stations an intrusion of new water was already observed. This water was slightly less saline (38.78) and colder (13.56°C) than the water which originated from Cretan Basin. In the field of potential density relative to 2000 db it is possible to see that the new deep water is denser by about 0.005 kg/m^3 than the relict water from the previous EMT renewal.

Further eastward propagation of the new water, which Roether et al. [1] defined as having Adriatic origin, was observed in summer 2008 during the R/V Shikmona cruise carried out in the framework of EU funded project SESAME (http://www.sesame-ip.eu). The western boundary of the Cretan origin water was shifted to about 27.5°E (Fig). The boundary is clearly observed in the salinity field (Fig) as well as in fields of potential temperature and dissolved oxygen. The Cretan origin deep water were disconnected from their origin in the Aegean Sea and became, due to mixing, less salty and colder (38.79, 13.63°C) than they were during 2001. The Adriatic origin water did not change its parameters compared to observation from 2001. Apparently this water mass had a permanent feeding from the Otranto strait. Differences in potential density between the Adriatic and Cretan water masses remained the same as in 2001 (about 0.005 kg/m^3). The eastward propagation rate of Adriatic origin water was seven times slower than the propagation of the Cretan origin water. This seems to be connected to the smaller difference in potential density.

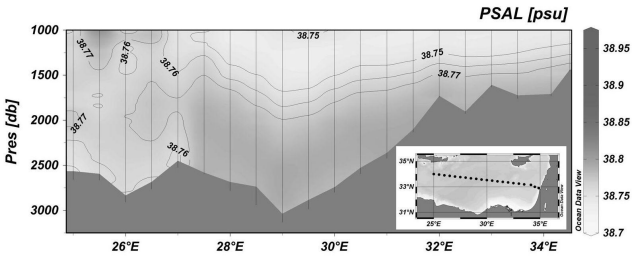


Fig. 1. Vertical distribution salinity in deep layers of the Levantine Basin. R/V Shikmona, summer 2008, SESAME project cruise.

References

1 - Roether W., Klein B., Manca B.B., Theocharis A., Kioroglou S., 2007. Transient Eastern Mediterranean deep waters in response to the massive dense-water output of the Aegean Sea in the 1990s. *Prog. Oceanog.* 74: 540-571.

2 - Gertman I.F., Pinardi N., Popov Y., Hecht A., 2006. Aegean Sea water masses during the early stages of the Eastern Mediterranean Climatic Transient (1988–1990). *J.f Phys. Oceanog.*, 36 (9): 1841–1859.

3 - Lascaratos A., Roether W., Nittis K., Klein B., 1999. Recent changes in deep water formation and spreading in the Mediterranean Sea: a review. *Prog. Oceanog.*. 44: 5–36.

GENERATION OF SHIKMONA ANTICYCLONIC EDDY FROM AN ALONGSHORE CURRENT

I. Gertman [1]*, R. Goldman [1], Z. Rosentraub [1], T. Ozer [1], G. Zodiatis [2], D. Hayes [2] and P. Poulain [3]
[1] Israel Oceanographic & Limnological Research, Haifa, Israel - isaac@ocean.org.il
[2] Oceanography Centre, University of Cyprus, Nicosia, Cyprus
[3] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Trieste, Italy

Abstract
During the summer of 2009, 6 Lagrangian drifters were launched in the South eastern Levantine basin, 3 of them near the Israeli coast. The drifters moved northward along the shelf and turned toward the deep sea off Haifa Bay. One of the drifters was trapped in a stationary meander for a week, later it moved in a trajectory that is interpreted as a detachment of the meander to an anticyclonic eddy. This eddy moved, within 4 days, northwest to a location where the Shikmona eddy was previously observed. Over the next 30 days the drifter demonstrated a stationary eddy position and then exited the eddy area. Satellite observations of high chlorophyll-a (Chl-a) concentration correspond to the geographical position of the meander and the eddy. Operational model forecasts in the area fail to generate the observed phenomena.
Keywords: Levantine Basin, Circulation

The south eastern circulation in the Levantine basin is generally characterized by a large scale cyclonic circulation. Development of a north bound jet current along the eastern continental slope is frequently observed [1]. Another energetic feature of the circulation is the anticyclonic Shikmona eddy observed generally in the vicinity of 33.8°N, 33.8°E [2]. The formation of the Shikmona eddy was attributed either to meandering of the Mid Mediterranean Jet in connection to dynamic instability near the Eratosthenes Seamount [3] or to meandering of the alongshore current [4]. The later mechanism was derived from SST analysis without in situ confirmation.

NEMED is an observational program, led by OGS [5], to quantify the circulation and eddy variability in the Eastern Mediterranean, with major attention to the eastern and northern regions of the Levantine sub-basin, using among others, low-cost satellite-tracked drifters in the vicinity of Cyprus and Israel. The first series of SVP drifters included 3 drifters which were launched on the Israeli continental slope near Ashdod by IOLR and 3 drifters which were launched on the line connecting Limasol and Port Said by the University of Cyprus. The continental slope drifters were carried north by the alongslope jet current with an estimated velocity of 20-30 cm/s. Their trajectories deviated westward south of Haifa Bay. Two drifters outlined a meander reaching about 70 km west of the shore and continued along the Lebanese and Syrian coast (Fig 1a). The third drifter was trapped in the meander for a week and then travelled, within 4 days, northwest in a spiraling trajectory (Fig 1b). Afterwards it outlined the Shikmona anticyclonic eddy centered at 34.2°E, 33.6°N with diameter of about 50 km and remained there for 30 days (Fig 1c). One of the drifters launched south of Cyprus was also trapped by the eddy in a larger orbit (80 km diameter) for two weeks.

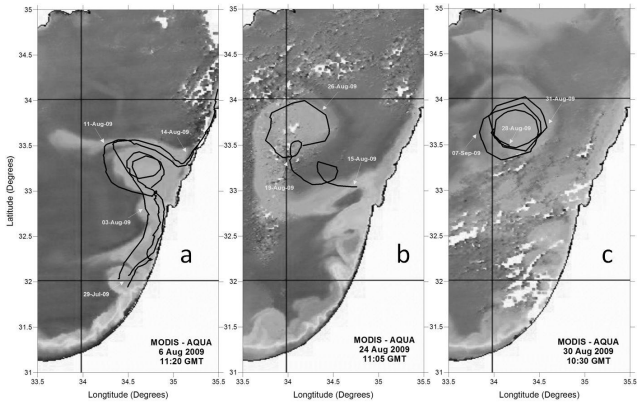


Fig. 1. Stages in the evolution of Shikmona Eddy from meander. Lines: Lagrangian drifters trajectories. Background: concentration of Chl-a (lighter shades represent higher concentrations).

Remote satellite observation of Chl-a provided by CYCOFOS [6] showed local concentration maximum in the center of the meander and later in the center of the eddy, corresponding to the trajectory of the trapped drifter in time and space. During the 30 day period Chl-a concentration gradually decreased until it was no longer discernable, around this time the drifter exited the eddy area. SST maps, unlike Chl-a, showed only a weak signal of the eddy. Model forecast from the same period run by IOLR did not reproduce the phenomena described above and showed the alongshore jet with no meandering.

References
1 - Rosentraub Z., and Brenner S., 2007, Circulation over the southeastern continental shelf and slope of the Mediterranean Sea: Direct current measurements, winds, and numerical model simulations, *J. Geophys. Res.*, 112, C11001, doi:10.1029/2006JC003775
2 - Gertman I., Zodiatis G., Murashkovsky A., Hayes D., and Brenner S., 2007. Determination of the location of southeastern Levantine eddies from CTD data. *Rapp. Comm. int. Mer Medit.*, 38: 151.
3 - Brenner S., 1989. Structure and evolution of warm core eddies in the eastern Mediterranean Levantine Basin. *J. Geophys. Res.*, 94: 12593–12602.
4 - Hamad N., Millot C., and Taupier-Letage I., 2005. A new hypothesys about the surface circulation in the eastern basin of the Mediterranean Sea, *Progress in Oceanography*. 66: 287-298.
5 - Poulain P-M. 2009. Surface Circulation in the Northeastern Mediterranean (NEMED), Report 2009.
http://nettuno.ogs.trieste.it/sire/drifter/nemed/ nemed_main.html.
6 - Zodiatis G., Hayes R.D., Lardner R. and Georgiou G., 2008, Sub-regional forecasting and observing system in the Eastern Mediterranean Levantine Basin: the Cyprus Coastal Ocean Forecasting and Observing System (CYCOFOS), *In:* Towards an integrated system of mediterranean marine observatories, *CIESM Workshop Monographs*, 34 ISSN 1726-5886,

M_2 TIDAL DYNAMICS IN ALGECIRAS BAY AND ITS RELATION TO THE HYDRODYNAMICAL REGIME OF THE STRAIT OF GIBRALTAR: NUMERICAL 3D MODEL RESULTS

C. J. Gonzalez [1]*, L. López [1], Ó. Álvarez [1], M. Bruno [1] and R. Mañanes [1]
[1] University of Cadiz. Department of Applied Physics, Puerto Real, Cadiz, Spain - carlosjose.gonzalez@uca.es

Abstract
A simulation of the M_2 tidal dynamics in Algeciras Bay (South of Spain) was conducted by use of a 3D hydrodynamical model and complemented with experimental data, focusing on the influence of the general hydrodynamical regime of the Strait of Gibraltar over the bay dynamics. The semidiurnal, mesotidal regime present in the strait, together with the strong density-stratification of the water column, was found to have important consequences for the particular tidal dynamics of Algeciras Bay. Firstly, model results showed the occurrence of a cross-current system between the Atlantic and Mediterranean water layers inside the bay. Secondly, the 3D hydrodynamical model was able to simulate accurately the so-called baroclinic internal wave, generated by hydraulic jump over Camarinal Sill, as well as its propagation into Algeciras Bay.
Keywords: Tides, Models, Strait Of Gibraltar

Study site
Algeciras Bay (South coast of Spain) constitutes a physical environment of special characteristics, due to its morpho-bathymetric configuration and geographical location, close to the eastern boundary of the Strait of Gibraltar. The interaction between the mesotidal, predominantly semidiurnal tidal regime of the Strait of Gibraltar with the water stratification, due to the presence of Atlantic water at the upper layer and Mediterranean water (more salty and cold) at the lower one, has important hydrodynamical consequences, as the generation of the so-called baroclinic internal wave over Camarinal Sill and effects on the vertical profiles of the velocity of currents. Because of its wide connection to the Strait, the tidal hydrodynamics of Algeciras Bay is expected to be submitted to this peculiar processes, so the aim of this study was to conduct a detailed research in that respect by analyzing both empirical and numerical 3D model data, comparing them and setting the main characteristics of the tidal dynamics in this environment.

The Model
The three-dimensional, nonlinear, high-resolution, finite-difference, sigma-coordinated UCA 3D hydrodynamical model is based on the numerical solving of 3D equations of motion (assuming the hydrostatic simplification). The system is coupled to a two-dimensional, depth-averaged scheme [1] by the splitting technique [2]. For the modeling of the M_2 tidal hydrodynamics in the Strait of Gibraltar and Algeciras Bay, a calculation domain was chosen extending from the western Strait boundary to the Alboran Sea. The model Arakawa-C staggered grid had a horizontal resolution of 500 m and 50 vertical sigma-levels. The system was forced by a single M_2 tidal wave and the zero-frequency constituent Z_0; initial conditions of free-surface elevation and current velocity (amplitudes and phases), as well as those of salinity and temperature, were obtained from the Experiment "Strait 94-96" and previous works by [3] and [4].

Results
Modeled time-spatial fields of the M_2 harmonic parameters, obtained by conventional harmonic analysis [5], were compared with available experimental values at 40 different locations. The root mean squares of errors were 4.0 cm and 4.4º for the amplitude and phase of elevation and 18.2 cm s^{-1} and 18.3º for those of depth-averaged current velocity. Focusing on the Algeciras Bay area, model results show a little spatial variation of M_2 elevation harmonic parameters, with amplitudes and phases around 31 cm 47º Greenwich. Modeled depth-averaged M_2 current ellipses present highest semimajor axes by the coastal margins (until 40 cm s^{-1}), while they do not overcome 10 cm s^{-1} through the deeper central canyon of the Bay. A more detailed analysis of vertical velocity profiles revealed that the latter is due to a system of tidal cross-currents between the Atlantic and Mediterranean water layers inside Algeciras Bay, being a phase-lag of near 180º between the current ellipses of both layers. Comparisons with experimental ADCP data through ship transects in the Bay area show a remarkable qualitative and quantitative correlation in that respect.

In relation to the time-spatial propagation of the baroclinic internal wave, Fig. 1 (top) shows an example of model spatial field of free-surface elevation together with remote-sensing satellite image at the corresponding tidal stage. It can be appreciated a significant correspondence between them, as well as the penetration of the eastwards internal wave front into Algeciras Bay. The wave parameters, estimated from model and satellite fields, are: period: 22 minutes; wavelength: 1.8 km; wave celerity: 4.9 km/h; the amplitudes of oscillations are of the order of 1 cm. The spectral density distribution of free-surface elevation from a CTD cast on the inner Bay (Fig. 1, bottom) shows a marked peak by period values close to the calculated from model results.

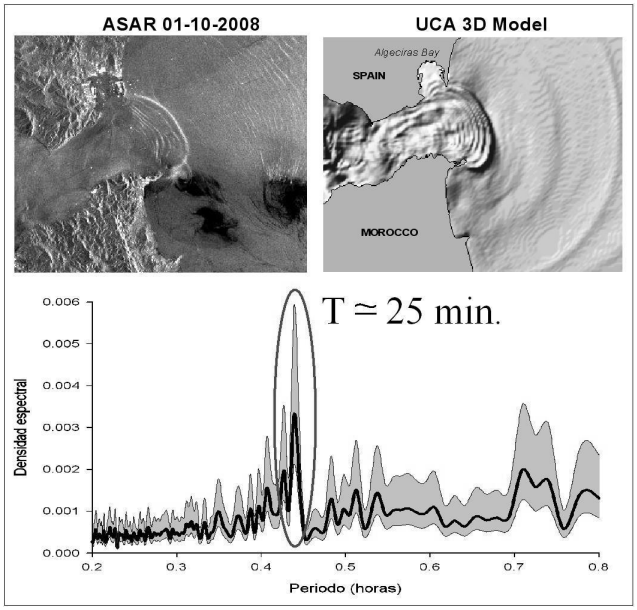


Fig. 1. Top: an example of ASAR image (left) and modeled field of free-surface elevation at analogue tidal stage (right). Bottom: spectral density distribution of free-surface elevation from a CTD cast inside Algeciras Bay, with periods up to 2 hours removed.

References
1 - Álvarez O., Izquierdo A., Tejedor B. et al., 1999. The influence of sediment load on tidal dynamics, a case study: Cádiz Bay. *Estuar. Coast. Shelf S.*, 48: 439–450.
2 - Madela R.V. and Piacsek S.A., 1977. A semi-implicit numerical model for baroclinic oceans. *J. Comput. Phys.*, 23: 167–178.
3 - Tejedor L., Izquierdo A., Sein D.V., et al., 1998. Tides and tidal energetics of the Strait of Gibraltar: a modelling approach. *Tectonophysics*, 294 (3–4): 333–347.
4 - Izquierdo A., Tejedor L., Sein D.V., et al., 2001. Control variability and internal bore evolution in the Strait of Gibraltar: a 2-D two-layer model study. *Estuar., Coast. Shelf S.*, 53 (5): 637–651.
5 - Foreman M.G.G. and Henry R.F., 1989. The harmonic analysis of tidal model time series. *Adv. Water Resour.*, 12: 109–120.

GLIDER TRANSECTS IN THE LEVANTINE SEA: A STUDY OF THE WARM CORE CYPRUS EDDY

D. Hayes [1]*, P. Testor [2], G. Zodiatis [1], G. Konnaris [1], A. Hannides [3], L. Mortier [2], L. Beguery [4], F. D'Ortenzio [5], E. Mauri [6], F. Lekien [7], R. Gerin [6], P. Poulain [6] and A. Lazar [2]

[1] Oceanography Center, University of Cyprus, Nicosia, Cyprus - dhayes@ucy.ac.cy

[2] LOCEAN-IPSL/CNRS, Universite Pierre et Marie Curie, Paris, France

[3] Department of Fisheries and Marine Research, Nicosia, Cyprus

[4] DT-INSU, La Seyne sur mer, France

[5] LOV, Villefranche-sur-mer, France

[6] OGS, Trieste, Italy

[7] ULB, Brussels, Belgium

Abstract

In March 2009, two gliders began occupying a hydrographic endurance line for measurements of temperature, salinity, dissolved oxygen, optical backscatter, and fluorescence in the Levantine Sea south of Cyprus in a butterfly pattern over the Eratosthenes Seamount. The line will extend in space and time an historical one. Comparison with past hydrographic cruise data shows similarities. In particular, a large anticyclonic eddy, the Cyprus Eddy, over the Eratosthenes Seamount dominates, with traces of Atlantic Water around the periphery. This eddy was investigated intensively by a fleet of gliders from November 2009 to January 2010.

Keywords: Hydrography, Levantine Basin

In March 2009, two gliders began occupying an endurance line for measurements of temperature, salinity, dissolved oxygen, optical backscatter, and fluorescence in the Levantine Sea south of Cyprus. The transects follow a butterfly pattern over the Eratosthenes Seamount, extending to a maximum depth of 1000 m. The operational transects represent the first in a planned time series for the next several years to be carried out by the Oceanography Center of the University of Cyprus (OC-UCY). Following the 4th EGO Meeting and Glider School in Larnaca in November 2009, a joint project, "EYE of the Levantine," was carried out in which 6 gliders were deployed to investigate the Cyprus warm core eddy observed earlier in the year by both glider and shipboard CTD. In December 2009, the *TARA Oceans* vessel was involved as well with CTD and water samples and the deployment of 4 surface drifters and 2 profiling floats in and around the eddy. Near the end of the experiment, the eddy was sampled again with shipboard CTD grid carried out by the *Maria S. Merian* in mid-January 2010. At this time, only one of the original gliders continued to collect data while beginning the second round of its endurance line, which should also pass through the eddy. About 2000 profiles down to 1000 m and 1000 profiles down to 200 m have been collected by the fleet of gliders including measurements of not only temperature and salinity, but also fluorescence (Chl a, CDOM) and backscatters (at 470, 532, 660, 700, and 880 nm).

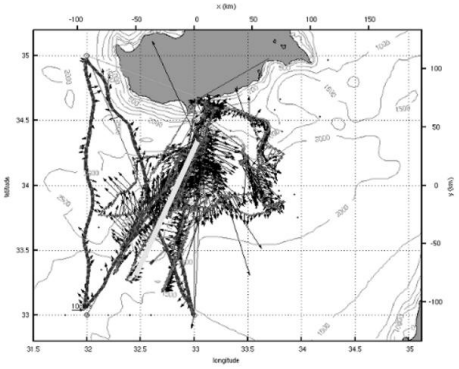


Fig. 1. Map of glider tracks with bathymetry and depth-averaged velocity centered over each dive from 23 November 2009 to 18 January 2010. One of the transects to be shown later is highlighted by a thick grey line.

Since the POEM cruises of the 1980s [1], the general vertical and horizontal distributions of the water masses of the region have been known: the Levantine Surface and Intermediate Water (LSW and LIW) masses sandwiching the Atlantic Water (AW), with the Eastern Mediterranean Deep Water (EMDW) at the deepest observed levels. The variability of the AW pathway, the eddy structures, and absolute transport are all to be addressed by the operational "section series," but in this paper, we present the results of the even more intensive sampling of an eddy using a fleet of gliders which provide a larger-scale synoptic view not possible with a single platform of any kind. The dominant feature of the data set is the anticyclonic (warm, salty core) eddy known as the Cyprus Eddy [2] near the Eratosthenes Seamount (Fig. 1). During the experiment the eddy had a radius of about 40 km and consisted of a core of LIW extending down to 500 m. Currents averaged over the 1000 m dives peaked at the edge with magnitudes of 0.30 m s^{-1}. During the experiment, the eddy shifted about 10 km to the east. The slightly fresher AW is found just below the thermocline, most often around the periphery of the Cyprus Eddy (Fig. 2). Dissolved oxygen, optical scattering, and chlorophyll fluorescence typically show maximum values also in the layer just below the thermocline.

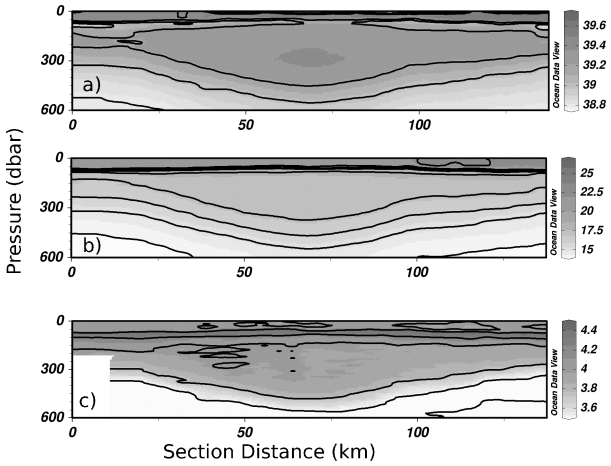


Fig. 2. Vertical section from North to South of a) salinity, b) potential temperature (deg C), and c) dissolved oxygen along transect highlighted in Fig. 1, from 24 November 2009 to 02 December, 2009.

Remotely-observed sea level anomaly (AVISO) products showed similar surface signals, at coarser resolution, as did drifter tracks. Operational forecasts were not as successful in predicting the eddy presence: OC-UCY forecasted a similar eddy, but in a slightly different location and time. Future work includes the assimilation of glider profiles into the operational forecasts at OC-UCY, and further comparison with satellite altimetry, remotely-sensed sea surface temperature and ocean color.

References

1 - Ozsoy E., Hecht A., Unluata U., Brenner S., Oguz T., Bishop J., Latif M.A., and Rozentraub Z., 1991. A review of the Levantine Basin circulation and its variability during 1985-1986. *Dyn. Atmos. Oceans*, 15: 421-456.

2 - Zodiatis G., Drakopoulos P., Brenner S., and Groom S., 2005. Variability of the Cyprus warm core Eddy during the CYCLOPS project. *Deep-Sea Res. II*, 52: 2897-2910.

IMPACT OF THE EASTERN MEDITERRANEAN TRANSIENT (EMT) ON THE NORTHWESTERN MEDITERRANEAN SEA (NWMS): THE CASE OF THE EXCEPTIONAL 2004-05 CONVECTION EVENT

Marine Herrmann [1]*, Jonathan Beuvier [2], Florence Sevault [1] and Samuel Somot [1]
[1] Centre National de Recherches Météorologiques, Toulouse, France - marine.herrmann@m4x.org
[2] ENSTA/UME, Palaiseau, France

Abstract
Spectacular convection occurred in the NWMS during 2004-05: the convection area was exceptionally large, and Western Mediterranean Deep Water (WMDW) formed this winter was warmer and saltier than usually. We perform numerical oceanic simulations to assess the respective contributions of oceanic and atmospheric conditions to this event. Our results suggest that WMDW characteristics are mainly related to the NWMS heat and salt contents before the convection. The increase of those characteristics in 2004-05 is due to an increase of those contents, due to the absence of strong convection during the 90's. Convection intensity is related both to the winter atmospheric conditions and to the autumn NWMS stratification. The EMT modified this stratification in autumn 2004, potentially doubling the volume of WMDW formed.
Keywords: Deep Waters, Gulf Of Lions, Western Mediterranean, Water Convection, Air-Sea Interactions

Open ocean deep convection takes place in a few regions of the world ocean, among which the NWMS [1]. In this region, the combination of cyclonic circulation and strong winter surface buoyancy losses associated to northern wind events (Mistral, Tramontane) induces deep convection events, at the origin of the formation of WMDW. During winter 2004-05, an exceptionally strong convection event was observed by several experimentators [2, 3, 4]: it covered an area much larger than usually, and the WMDW formed this winter was significantly saltier and warmer than the values reported in the literature.

Two major explanations for the exceptional characteristics of this convection event (intensity and WMDW characteristics) were proposed by those authors: the first one relates the exceptional intensity of this convection event, as well as the change of the characteristics of the WMDW formed this winter to the atmospheric conditions. The second one relates them to the effect of the EMT on the Ligurian Intermediate Water (LIW), hence on the oceanic conditions. To determine which element played a role in this event, and how, we performed several numerical simulations.

First we performed a realistic numerical simulation of the Mediterranean oceanic circulation during the 1958-2006 period. The long term analysis of this simulation was performed by [5], who validated the long-term evolution of the temperature and salinity in the basin and showed that the model is able to reproduce correctly the EMT. This control simulation is able to reproduce very realistically the 2004-05 NWMS convection event, in terms of chronology, intensity and WMDW characteristics.

We also performed sensitivity simulations, in order to assess the contributions of the oceanic and atmospheric conditions to this convection event. The results show that, for given atmospheric conditions, the temperature and salinity of the WMDW are linearly related to respectively the heat and salt contents of the NWMS just before the convection event (Fig. 1). They suggest that the change of WMDW characteristics observed in 2004-05 was related to an increase of those heat and salt contents during the last decade. The model suggests that this increase was not due to the EMT, but to the absence of deep convection during the 90's enabling salt and heat to accumulate in the LIW. This absence of strong convection was related to the weakness of the winter buoyancy loss during this period. WMDW characteristics are therefore not influenced by the atmospheric conditions during its formation, but by the evolution on those conditions on the long term. The EMT induced a deepening of the LIW in the Western basin, observed by [6] and reproduced by the model, that resulted in a decrease of the stratification of the water column compared to what could have been the case without the EMT. Our results show that, for given atmospheric conditions, the intensity of deep convection in terms of WMDW formed is linearly related to the stratification of the water column just before the convection event. Moreover, in 2004-05, convection reaches the bottom in all the simulations, whatever the pre-convection stratification. It therefore appears that the strong atmospheric conditions during winter 2004-05 were responsible for the intensity of the convection this year, but that the EMT accentuated this intensity by weakening the stratification, and potentially doubled the volume of WMDW formed.

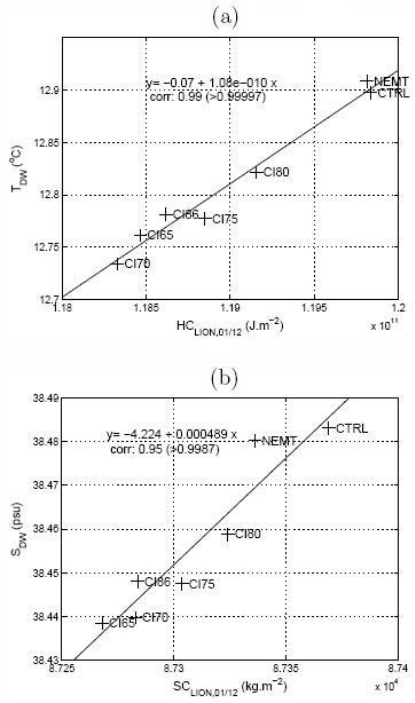


Fig. 1. Relations between the pre-convection heat (a), resp. salt (b), content over the Gulf of Lions and the WMDW temperature, resp. salinity.

References
1 - Marshall J. and Schott F., 1999. Open-ocean convection: observations, theory, and models. *Rev. Geophys.*, 37 (1): 1–64.
2 - Schroeder K., Ribotti A., Borghini M., Sorgente R., Perilli A. and Gasparini G.P., 2008. An extensive western Mediterranean deep water renewal between 2004 and 2006. *Geophys. Res. Lett.*, 35, L18605.
3 - Smith W. and Sandwell D., 1997. Global sea floor topography from satellite altimetry and ship depth sounding. *Science*, 277 (5334): 1956–1962.
4 - Font J., Puig P., Salat J., Palanques A. and Emelianov M., 2007. Sequence of hydrographic changes in NW Mediterranean deep water due to the exceptional winter of 2005. *Sci. Mar.* 71(2): 339–346.
5 - Beuvier J., Sevault F., Herrmann M., Kontoyiannis K., Ludwig W., Rixen M., Stanev E., Béranger K. and Somot S., In revision. Modelling the Mediterranean Sea interannual variability over the last 40 years: focus on the Eastern Mediterranean Transient (EMT). *J. Geophys. Res.*
6 - Gasparini G., Ortona A., Budillon G., Astraldi M. and Sansone E., 2005. The effect of the Eastern Mediterranean Transient on the hydrographic characteristics in the Strait of Sicily and in the Tyrrhenian Sea. *Deep-Sea Res. II*, 52(6): 915–935.

INTEGRATION DES DONNEES MULTISOURCES POUR LA MODELISATION DE LA COULEUR DES EAUX MARINES COTIERES: APPLICATION A LA SURVEILLANCE DU PHYTOPLANCTON MARIN.

Fouzia Houma [1]*, Toufik Touahria [2], Nour El Islam Bachari [2] and Rabah Belkessa [1]
[1] École Nationale des Sciences de la Mer et de l'Aménagement du littoral ENSSMAL, Alger, Algeria - houmabachari@yahoo.fr
[2] Université des Sciences et de la Technologie Houari Boumediene, 16111 Bab Ezzaouar, Alger, Algeria

Abstract
La connaissance de la qualité de l'eau est une composante essentielle dans la gestion intégrée du littoral. L'aspect biologique de cette composante est sans aucun doute le plus difficile à prendre en compte, du fait de la complexité des mécanismes gouvernant la production primaire en milieu côtier. Les propriétés optiques des algues, des substances organiques dissoutes et des particules non organiques en suspension peuvent considérablement affecter la couleur de l'eau de mer. Inversement, des mesures précises de la couleur de l'eau et de sa réflectance spectrale permettent d'estimer la concentration de ses composants en utilisant des modèles mathématiques appropriés.
Keywords: Coastal Models, Phytoplankton, Remote Sensing, Pollution, Ocean Colours

Introduction
L'objectif général de ce travail est la caractérisation de la couleur de l'eau de la baie d'Alger à partir des données satellites. L'application permet de quantifier la concentration de la chlorophylle et celle du phytoplancton, qui ont un effet sur la «couleur de l'eau de mer », à partir de mesures satellites [1]. Dans ce contexte, la démarche suivie se base sur le concept de mesures *in situ* et l'interpolation des résultats trouvés par similitudes ou par des modèles mathématiques. Une corrélation importante entre le compte numérique du premier canal du satellite Landsat TM et la concentration en matières en suspension a été également réalisée [2]. Les bandes spectrales *Thematic Mapper* étaient utilisées davantage pour corréler avec les propriétés spectrales de l'eau et sa teneur en matière organique ou encore pour la caractérisation de la couleur, la salinité et la concentration en chlorophylle de l'eau de mer. D'autres chercheurs ont montré par l'utilisation des techniques optiques la possibilité d'établir des cartes de chlorophylle a, matières en suspension totales ou carbone organique dissous [3]. En s'inspirant des différentes approches développées et des caractéristiques des satellites Spot et Seawifs, nous avons essayé de mettre en évidence l'utilisation de la télédétection afin de trouver des relations entre les paramètres optiques et les descripteurs de la qualité de l'eau. Il devient donc nécessaire de s'appuyer sur des modèles de réflectance que l'on inverse pour déterminer la teneur de l'eau en ses différents éléments [4]. Nous présentons dans cet article: (a) les mesures physico-chimiques des différentes qualités d'eaux ; (b) les résultats des réflectances obtenues à partir des données numériques des satellites et (c**)** la modélisation des paramètres physico-chimiques, la chlorophylle et le phytoplancton marin dans les profondeurs de la baie d'Alger dans chaque bande spectrale du satellite.

Analyse de l'eau de mer et extraction de la réflectance
Nous avons utilisé l'image satellite SeaWiFS (Sea-Viewing Wide Field-of-view Sensor) pour fournir des données sur les propriétés bio-optiques de l'eau et des principaux paramètres biologiques, notamment la chlorophylle *a* à la surface de l'eau de mer. Pour extraire la réflectance de chaque pixel de l'image, on transforme l'image compte numérique (CN) en image Luminance.

Resultats et discussion
- Variation des mesures *in situ* et les indicateurs organoleptiques. La distribution spatiale de la chlorophylle *a* et des phéopigments dans la baie d'Alger montrent une grande similitude pendant les périodes de prélèvement. Nous avons pour chaque campagne deux zones distinctes de concentration en chlorophylle *a* et phéopigments**.** En absence d'activité biologique, la concentration d'oxygène dissous tend vers la saturation de l'eau**,** qui est en fonction de la température et de la salinité (à pression atmosphérique normale) [1], [5]. Les faibles teneurs de l'oxygène dissous dans l'eau de mer à proximité des rejets sont préoccupantes, et montrent une consommation excessive de l'oxygène qui a des conséquences très graves et fatales sur la vie aquatique en entraînant un phénomène d'eutrophisation du littoral (des pullulations d'algues vertes *Ulva Enteromorpha* ou de phytoplancton *bloom*).

- Analyse des réflectances. La distribution de la teneur en chlorophylle dans l'eau de mer est mise en relation avec la turbidité ; ceci peut expliquer les taux de liaison trouvés sur les canaux visibles Spot et Seawifs étant donné que les eaux où domine le phytoplancton présentent un maximum de réflectance dans le jaune vers 565 nm [5]. Il y a donc une réflexion considérable dans ce domaine spectral qui justifie que les canaux visibles peuvent servir pour étudier la couleur de l'eau de mer et pour en déduire la concentration en sédiments et la concentration en chlorophylle *a*.

- Spatialisation des paramètres et images satellites. En utilisant le logiciel PCSATWIN d'images satellites, nous avons transformé l'image réflectance en une image qui permet d'estimer dans certaines mesures la concentration de la chlorophylle et celle des espèces phytoplanctoniques dominantes dans la région. En réalité, la couleur de l'eau de mer, qui est l'un des descripteurs organoleptiques évident, reste toujours un facteur important de différenciation qui renseigne sur la lueur de l'eau, sur sa qualité, et qui peut servir comme un indicateur de sa transparence [5].

Conclusion
La modélisation a rendu réalisable la détermination de la couleur de l'eau et de la chlorophylle à partir des satellites. La spatialisation des valeurs mesurées sur le terrain facilite en effet le suivi environnemental de la qualité des eaux et les interventions sur le milieu. Une surveillance directe des populations phytoplanctoniques, couplée avec l'utilisation de capteurs satellitaires et le Système d'Information Géographique, peut améliorer grandement notre connaissance de l'état des eaux côtières et établir une carte de la couleur de l'eau et de la biomasse phytoplanctonique.

References
1 - Ferrari G.M. and Tassan S., 1992. Evaluation of the influence of yellow substance absorption of the remote sensing of water quality in the Golf Naples: a case study. *Int. J. Remote Sens*., 13 (12): 2177-2189.
2 - Baban J. and Serwan M.J.,1993. Detecting water quality parameters in Norfolk Broads, U.K., using Landsat imagery. *Int. J.Remote Sens.*, 14: 1247-1267.
3 - Bachari N., Benabadji N. and Abdellaoui A., 1997. Développement du logiciel d'analyse spectrale et temporelle des images satellite type SPOT, LANDSAT et METEOSAT, *A.M.S.E. Journal*, 38 (1-2): 15-34.
4 - Houma F., Belkessa R., Khouider A., Bachari N. and Derriche Z., 2004. Etude corrélative des paramètres physico- chimiques et des données satellites IRS1C pour caractériser la pollution aquatique. Application à la baie d'Oran, Algérie. *Rev. Sci. Eau*, 17 (4): 429- 446.
5 - Houma F., 2007. Caractérisation des polluants de la côte oranaise et algéroise par analyse physico-chimique et corrélation avec les données satellites. Thèse de doctorat, USTHB, Algérie, 225 pp.
6 - Touahria T., 1999. Etude de la biomasse, de la composition et de la structure des peuplements phytoplanctoniques de la mer d'Alboran Est. Thèse de magister, spécialité Océanographie, USTHB, Algérie, 200 pp.

INVESTIGATION OF THE MEDITERRANEAN-BLACK SEA COUPLING USING MULTI-SCALE MODELS OF THE TURKISH STRAIT SYSTEM

Sinan Husrevoglu [1]*, Emin Ozsoy [1], Adil Sozer [1] and Ozgur Gurses [1]
[1] Institute of Marine Sciences - Middle East Technical University, Mersin, Turkey - sinan@ims.metu.edu.tr

Abstract
A multi-scale, high-resolution ocean-ecosystem numerical model suite is implemented for the Turkish Strait System (TSS) to study the dynamics of the coupling between the Black Sea and the Mediterranean, specifically to assess the role of TSS on the behaviour of the coupled ecosystems, to understand the relative importance of remote and local forcing mechanisms on the exchange flows and mixing in the TSS, and to quantify the two-way transport of materials through the TSS. Since the problem of coupling between the adjacent basins of the Black and Mediterranean basins is truly a complex one, an assembly approach is used. Various levels of models are used, producing simulations corresponding to different levels of approximation in order to enable feedbacks on the effects of resolution, model parameterizations, and setup between these levels.
Keywords: Models, Bosphorus, Dardanelles, Marmara Sea, Black Sea

The TSS is much like a fjord system, characterized by two-layer exchange flow with a strong pycnocline maintained by density and sea level gradients between the Black Sea and the Aegean Sea, and controlled by hydraulic constraints in the straits and exit regions. The depth of the interface undergoes high temporal and spatial variability inside the straits and their exit regions, but has a relatively stable depth at about 25m in the Marmara Sea proper, occasionally exceeding this depth under conditions of extreme surface mixing. The Marmara Sea is a small, enclosed body of water with complex topography, comprised of three deep basins of depth greater than 1000m each, separated by deep sills of 600-700m in depth, adjoining a wide continental shelf of 100m depth occupying the southern half of the basin, which then connect to the straits through canyons extending out from them. Horizontal re-circulating flows under constraints of a highly irregular coast in the confined geometry of the Marmara Sea induce horizontal shears and inhomogeneity. The surface exit flows from straits into the Marmara and Aegean basins are in the form of buoyant turbulent jets. The relatively fresh surface water (*S = 18*) entering from the Black Sea is modified to reach higher salinities (*S =22-30*) within the upper layer of the Marmara Sea, separated from the underlying salty Mediterranean water (*S = 38.5*). The wider Marmara Sea acts as a buffer zone, or a 'stilling basin' between the two larger basins. The shallowness of the upper layer makes its response to winds and other driving forces extremely rapid.

Due to the lack of sufficient computational resources to handle the required fine-scale spatial resolution, present ocean numerical models implemented for the coupled Mediterranean – Black Sea system can neither correctly simulate the stratified exchange flow between these basins through the Turkish Straits nor the compounded effects of such exchange on the energetics, stratification, and sea level in these adjacent seas. Extremes in cross-shelf interaction, such as dense water cascading, surface jets, hydraulically controlled, super-critical, non-linear, non-hydrostatic, layered and occasionally blocked flows occur in the region of the straits, in response to remote forcing from the adjacent seas and the complex topography with very fine details.

In parallel with advances in computer technology, ocean general circulation numerical models (OGCM) have become widely used tools to estimate the consequences of physical, chemical, and biological processes in the ocean and to evaluate the ocean response to atmospheric forcing under realistic and extreme scenarios.

Modeling the Turkish Straits System (TSS) and its role in coupling the adjacent seas is a grand challenge. Features described above make it a formidable problem to forecast currrents and circulation in the Turkish Straits System. Traditional ocean models with simplified physics and topographical representation are often unable to comprehensively capture the features and multiple space-time scales that are involved. A true and full coupling considering the entire system of adjacent Mediterranean and Black Sea basins is in fact far beyond reach for most of the present day ocean models. Therefore, a multi-scale, three-level, hierachical numerical model suite is designed and executed in an attempt to realistically represent the challenging physical and biogeochemical dynamics of the TSS.

For the first level, a barotropic unstructured grid model (MOG2D) is set up covering the Mediterranean and the Black Sea together to predict water levels and net transport through the straits. On the second level, a laterally integrated (x-z) time dependent model solving two-dimensional vorticity equation is adapted for the Bosphorus and is initialized with a lock-exchange situation, specifying property contrasts between adjacent seas. The third level consists of three-dimensional models of the Bosphorus and Dardanelles Straits driven by net through-flow, boundary conditions specified in the adjacent Aegean and Black Seas and a three-dimensional model of Marmara Sea alone, excluding the straits and attempting to simulate Marmara Sea circulation based on strait exit boundary conditions. The third level models are all based on the Regional Ocean Modeling System (ROMS) [1]. The Fennel ecosystem components [2] are implemented as well in the three-dimensional ROMS models of the Bosphorus, Dardanelles Straits and the Marmara Sea.

Control runs with the Bosphorus model show that major features of the observed currents are successfully reproduced by the model (Figure 1). Following the set-up and testing phase, the control runs established from hindcasts produced by the dynamical and coupled ecosystem models of the TSS are validated with available data and fine-tuned before advancing to forecast, and potentially operational modes of simulation.

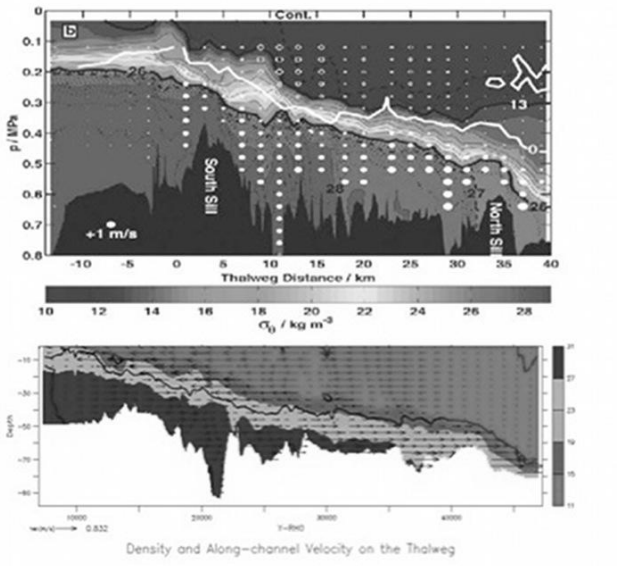


Fig. 1. Observed (top) and simulated (bottom) velocity and density distribution along the thalweg of the Bosphorus Strait.

References
1 - Shchepetkin A F. and McWilliams J.C., 2005. The Regional Ocean Modeling System: A split-explicit, free-surface, topography following coordinates ocean model. *Ocean Model.*, 9: 347– 404.
2 - Fennel K., Wilkin J., Levin J., Moisan J., O'Reilly J. and Haidvogel, D., 2006. Nitrogen cycling in the Middle Atlantic Bight: Results from a three-dimensional model and implications for the North Atlantic nitrogen budget. *Global Biogeochem. Cy.*, 20: GB3007, doi:10.1029/2005GB002456.

HIGH RESOLUTION 3D VELOCITY FIELD RECONSTRUCTION FROM SATELLITE SEA SURFACE TEMPERATURE OBSERVATIONS IN THE MEDITERRANEAN SEA

J. Isern-Fontanet [1]*, B. Chapron [2], P. Klein [3], G. Lapeyre [4] and E. Pallas-Sanz [5]
[1] Institut Català de Ciències del Clima, Barcelona, Catalonia - jisern@ic3.cat
[2] Laboratoire d'Océanographie Spatiale, Plouzané, France
[3] Laboratoire de Physique des Océans, Plouzané, France
[4] Laboratoire de Météorologie Dynamique, Paris, France
[5] Scripps Institution of Oceanography, La Jolla, USA

Abstract

Recent studies suggest that the dynamics in the upper layers of the ocean can be modeled with an effective version of the Surface Quasi-Geostrophic (eSQG) equations. The validity of this approach implies that the 3D velocity field can be reconstructed for the firsts 300-500 m from a Sea Surface Temperature (SST) snapshot. Then, the main objectives of this study are to investigate the applicability of the eSQG approach in the Mediterranean sea and to determine if the eSQG approach can be used to reconstruct vertical velocities from real infrared satellite data. To this end we will focus on the comparison of satellite derived fields with in situ measurements.

Keywords: Western Mediterranean, Remote Sensing, Mesoscale Phenomena, Instruments And Techniques, Currents

An important problem in oceanography is the estimation of the synoptic 3D velocity field, which is currently available only from expensive and labour-intensive in situ measurements. Altimeters measurements allow us to reconstruct the 2D velocity field of the ocean's surface with resolutions of the order of 100-150 km. However, high resolution satellite observations in the visible and infrared parts of the spectrum have shown an ocean very active at scales between 10 and 100 km. Although Sea Surface Temperature (SST) observations in the infrared spectrum provide a qualitative picture of the ocean dynamics at these scales, it is very diffiult to extract surface velocities from them and it is impossible to access vertical velocities.

Recent advances in our understanding of the dynamics of the upper layers of the ocean suggest that these can be modeled with an effective version of the Surface Quasi-Geostrophic (eSQG) equations [1]. The validity of this approach implies that, in situations for which the SST anomaly is representative of the density anomaly below the mixed layer, the stream function and density anomaly can be reconstructed for the firsts 300-500 m with resolutions of 10 km from a single SST image as

$$\hat{\psi}(\vec{k},z) = \frac{g\alpha}{\rho_0 f_0 n_T}\frac{\hat{T}_s(\vec{k})}{k}\exp(n_0 k z)$$

and

$$\hat{b}(\vec{k},z) = -\frac{g\alpha}{\rho_0}\hat{T}_s(\vec{k})\exp(n_0 k z).$$

Here ˆ stands for the horizontal Fourier, k is the wave-vector modulus, f_0 is the Coriolis frequency, g the gravity constant, α the thermal expansion coefficient, n_0 is a "mean" Brunt-Väissälä and n_T an "effective" Brunt-Väissälä frequency that takes into account the contribution of the interior PV and the partial compensation of thermal fronts by salinity [1,2]. n_0 is usually derived from existing observations of the large-scale density field while n_T is usually estimated comparing surface fields with independent observations [2,3]. Furthermore, as it has been shown by [1, 4], vertical velocities can be diagnosed as

$$\hat{w}(\vec{k},z) = -\frac{1}{n_T^2}\left[\widehat{J(\psi_s,b_s)}\exp(n_0 k z) + \widehat{J(\psi,b)}\right],$$

which is an alternative to the classical Omega equation.

The Mediterranean is an area that could benefit significantly from the use of infrared SST imagery to study the surface circulation at scales below 100 km. On one side, the percentage of pixels without clouds is quite high. On the other side, an important part of the mesoscale dynamics is not readily observable with existing altimeters since the Rossby radius of deformation is of 10-15 km.

As in [5], we have started our study analyzing in situ and satellite data from the Omega campaign. The data analyzed corresponds to the three consecutive samplings of the northern part of the Western Alboran Gyre carried on between October 1 - October 11, 1996 (see the figure). They consisted on temperature and salinity measurements obtained from an undulating CTD and velocities from a ship mounted ADCP . On the other side, satellite data consisted on nighttime infrared measurements from the AVHRR sensor on the NOAA-14 satellite provided by MeteoFrance.

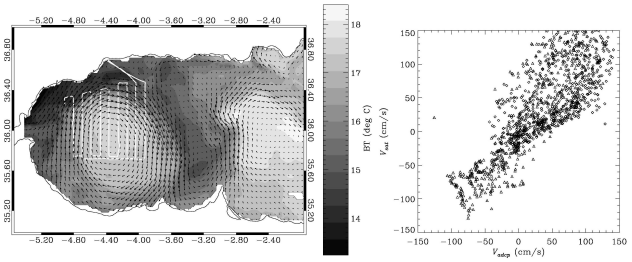


Fig. 1. Left: Brightness Temperature corresponding to October 8, 1996 with the derived surface velocities and the ship track between October 6 and October 9 superimposed. Right: scatter plot between surface velocities measured by the ADCP instrument and geostrophic velocities estimated from satellite data.

To estimate the velocity field using the above equations we need to reduce the noise level of satellite images. Therefore, we used Brightness Temperatures (BT) from channel 4 of the AVHRR instrument instead of SST and we further reduced the noise level using a wavelet-based denoising method. Then, the resulting geostrophic surface velocities (see the example in the figure) were linearly interpolated in time and space to the positions of real velocities observed by the ADCP. Preliminary results (see the figure) revealed a relatively good coincidence between both fields with a linear correlation of 0.8. In this case the "effective" Brunt-Väisälä frequency, n_T, was set to match the kinetic energy of ADCP velocities. The ability to reconstruct vertical velocities is under study.

References

1 - Lapeyre G. and Klein P., 2006. Dynamics of the upper oceanic layers in terms of surface quasigeostrophy theory. *J. Phys. Oceanogr*., 36: 165–176.
2 - Isern-Fontanet J., Chapron B., Klein P. and Lapeyre G., 2006. Potential use of microwave SST for the estimation of surface ocean currents. *Geophys. Res. Lett*., 33: L24608, doi:10.1029/2006GL027801.
3 - Isern-Fontanet J., Lapeyre G., Klein P., Chapron B. and Hetcht M., 2008. Three-dimensional reconstruction of oceanic mesoscale currents from surface information. *J. Geophys. Res*. C09005.
4 - Klein P., Isern-Fontanet J., Lapeyre G., Roullet G., Danioux E., Chapron B., Le Gentil S. and Sasaki H., 2009. Diagnosis of vertical velocities in the upper ocean from high resolution sea surface height. *Geophys. Res. Lett*., 33: L24608.
5 - LaCasce J.H. and Mahadevan A., 2006. Estimating subsurface horizontal and vertical velocities from sea surface temperature. *J. Mar. Res*., 64: 695–721.

VOLUME FLUX VARIABILITY IN THE BOSPHORUS STRAIT

E. Jarosz [1]*, W. J. Teague [1], J. W. Book [1], S. Besiktepe [2], M. Kodioglu [3], M. Hulbert [1] and A. Quaid [1]
[1] Naval Research Laboratory, Stennis Space Center, MS, USA - ewa.jarosz@nrlssc.navy.mil
[2] NATO Undersea Research Center, La Spezia, Italy
[3] Istanbul Technical University, Istanbul, Turkey

Abstract

Recently collected time series of currents, salinity, and temperature were used to estimate volume transports along sections located across the northern and southern ends of the Bosphorus Strait. The volume fluxes in upper and lower layers display high variability that is especially distinct in the upper layer and is coherent with the water level difference between the ends of the strait and along-strait wind stress.

Keywords: Bosphorus, Water Transport, Currents

The Bosphorus (Istanbul) Strait is a part of the Turkish Straits System (TSS) that also includes the Sea of Marmara and further towards the south the Dardanelles (Çanakkale) Strait. The TSS is the only connection between the Black and Aegean/Mediterranean Seas, and plays a paramount role in water mass exchange between these basins. It has been established for centuries that due to the density contrast in the adjacent basins, the basic exchange flow in the Bosphorus Strait is characterized by Black Sea brackish waters flowing southward in a surface layer, and salty waters from the Sea of Marmara moving northward below (Marsigli, 1681; Ünlüata et al., 1990; Latif et al., 1991; Gregg and Özsoy, 2002). Furthermore, this two-layer exchange is modified by the atmospheric forcing and variability of the water levels in the Black and Marmara Seas.

The United States Naval Research Laboratory (NRL) and the NATO Undersea Research Center (NURC) in collaboration with the Turkish Navy Office of Navigation, Hydrography and Oceanography deployed two mooring sections (Black Sea and Marmara Sea entrances) in the Bosphorus Strait as a part of the TSS08 (NURC project) and EPOS (NRL project) programs in September 2008. Each section was configured with: two BARNY moorings (ADCP, wave/tide gauge, temperature, and conductivity sensors) and one line mooring with seven pressure, temperature, and conductivity sensors (T/C sensors). All moorings were recovered at the beginning of February 2009. Full high quality time series were returned from the BARNY moorings. Unfortunately, both line moorings were partially damaged; hence, the data return was limited.

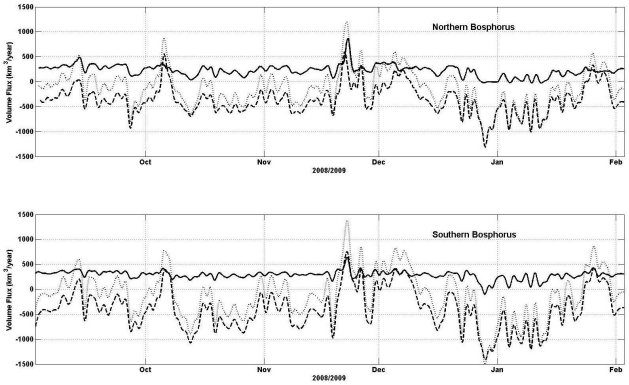


Fig. 1. Volume transports (km3/year) in the Bosphorus Strait: upper layers – dashed line; lower layers – continuous line, and net volume flux – dotted line.

The available data were then used to estimate volume transports in the upper and lower layers in the Bosphorus Strait. Times series of transport (upper, lower, and net) for both ends of the strait are shown in Figure 1. Time series means (September 2, 2008 – February 3, 2009) are 401 km^3/year, 286 km^3/year, and 115 km^3/year for the upper layer, lower layer, and net transports, respectively, along the southern entrance section, and 361 km^3/year, 222 km^3/year, and 139 km^3/year for the upper layer, lower layer, and net transport, respectively, along the northern entrance section. Additionally, at both locations, the volume transport shows high variability. This variability is generally more distinct for the volume flux of the upper layer. The fluctuations there could be twice as large as their respective mean values. Results from multiple and partial coherence analyses indicate that the variability of the upper layer transport is primarily highly coherent with the water level difference between the Black and Marmara Seas, secondarily with the local along-strait wind stress, and thirdly with the atmospheric pressure. The atmospheric forcing and water level difference can easily account for at least 70% of the variance of the upper layer volume transport in the Bosphorus Strait.

References

1 - Gregg M.C. and Özsoy E., 2002. Flow, water mass changes, and hydraulics in the Bosphorus. *J. Geophys. Res.*, 107, doi:10.1029/2000JC000485.

2 - Latif M.A., Özsoy E., Oguz T. and Ünlüata Ü., 1991. Observations of the Mediterranean inflow into the Black Sea. *Deep-Sea Res.*, 38 (Suppl. 2): S711–S723.

3 - Marsigli L.F., 1681. Osservazioni intorno al Bosforo Tracio overo Canale di Constantinopoli rappresentate in lettera all sacra real maesta di Cristina Regina di Svezia, Roma, 108 pp.

4 - Ünlüata Ü, Oguz T., Latif M.A. and Özsoy E., 1990. On the physical oceanography of the Turkish Straits. *In*: Pratt, L.J. (Ed.), The Physical Oceanography of Sea Straits. NATO ASI Ser. Kluwer Academic Publishing, Dordrecht, pp. 25–60.

WESTERN MEDITERRANEAN WAVE CLIMATE CHANGE SCENARIOS FOR THE XXIST CENTURY

G. Jordà [1], M. Marcos [1], D. Gomis [1]*, F. M. Calafat [1] and M. Gómez [2]
[1] Institut Mediterrani d'Estudis Avançats (CSIC-UIB), Esporles, Spain - damia.gomis@uib.cat
[2] Puertos del Estado, Madrid, Spain

Abstract
Future wave climate in the Western Mediterranean under different emission scenarios will be presented and compared to present day climate. The results are obtained with a 1/6º wave model forced by 6-hours winds generated by a dynamical downscalling over the Mediterranean with 50km resolution. Changes in the seasonal cycle, dominant patterns and extreme events will be assessed.
Keywords: Waves, Models

The knowledge of surface wave climate is of great importance to the design of offshore structures, coastal environment protection and the planning of operations at sea, among other maritime activities. Therefore, the identification of changes in the wave climate produced by future emission scenarios is crucial for the long term management of those activities. In this contribution, we present a consistent and homogeneous dataset of past and future wave climate in the Western Mediterranean. The dataset is based on the results of a numerical model and consists on a reanalysis of past climate (1960-2000), three runs of future climate (2000-2100) under different emission scenarios (B1, A1B and A2) and a complementary control run of present climate assuming only present emissions (with no data assimilation in the atmospheric forcing). The WAM model [1] has been implemented in the Western Mediterranean with a 1/6º resolution. The wave model is forced with 6-hours winds provided by the ARPEGE climate model that provides information over a variable resolution grid (~50km resolution over the Mediterranean [2]).

The reanalysis simulation results are compared with wave buoy measurements showing a good agreement in terms of mean values and correlation (Table 1). The changes in the wave climate will be assessed through different diagnostics. First we will look at the evolution of the seasonal cycle of SWH (Significant Wave Height) and Tm (Mean Period). Preliminary results suggest a reduction of the winter mean SWH that ranges from 10% in the B1 scenario to 50 % in the A2 scenario at the end of the XXIst century. This will be accompanied by a reduction of 5-10% in Tm for the same period.

Tab. 1. Comparison of modelled and buoy measurements of wind and wave pameters. The average values at three different observing sites are presented

	Buoy Mean	Buoy STD	Model Mean	Model STD	Correlation model-obs
Wind speed	6.3 m/s	4.1 m/s	5.9 m/s	3.3 m/s	0.84
SWH	1.1 m	0.85 m	0.89 m	0.69 m	0.92
Tm	4.1 s	0.9 s	3.5 s	0.9 s	0.82

In a second step, the good agreement of the reanalysis dataset with observations supports a characterization of the present day climate in terms of dominant patterns (EOF analysis) of SWH. Then, future changes could be assessed projecting the results of future climate runs on the present day EOFs. In our presentation, we will show the main changes of wave climate relating them to changes in the wind climate.

Finally, extreme wave events will be characterized in terms of their occurrence number, duration and intensity, both for the present-day climate and for the future climate. First results (Table 2) suggest that the number of wave storms and their intensity will decrease by the end of the XXIst century due to the weakening of winds and cyclone activity over the Western Mediterranean.

Tab. 2. Changes in the extreme events characteristics in under different emission scenarios for a point located to the south-west of Mallorca Island

Variable	Scenario	1960-2000	2060-2100
SWH 99.5 Percentile	B1	4.5 m	4.2 m
SWH 99.5 Percentile	A1B	4.5 m	3.8 m
SWH 99.5 Percentile	A2	4.5 m	4.1 m
Nº days/year with SWH >4.5 m	B1	9.8	7.6
Nº days/year with SWH >4.5 m	A1B	9.8	6.0
Nº days/year with SWH >4.5 m	A2	9.8	7.3

References
1 - WAMDI Group: Hasselman S., Hasselman K., Janssen P.A.E.M, Komen G. J., Bertotti L., Lionello P., Guillaume A. , Cardone V. C., Greenwood J. A., Reistad M., Zambresky L. and Ewing J. A., 1988. The WAM model - A third generation ocean wave prediction model. *J. Phys. Oceanogr.*, 18: 1775-1810
2 - Herrmann, M. J. and Somot S., 2008. Relevance of ERA40 dynamical downscaling for modeling deep convection in the Mediterranean Sea, *Geophys. Res. Lett.*, 35, L04607, doi:10.1029/2007GL032442

SEA SURFACE TEMPERATURE ANOMALIES IN THE SOUTH EASTERN MEDITERRANEAN SEA

Salama M. Kamel [1], Ibraim A. Mayza [1] and Mohamed A. Said [1]*
[1] National Institute of Oceanography & Fisheries, Qayet-Bey, Alexandria, Egypt - masaid@yahoo.com

Abstract
The hydrographic data of 61 years were used to study the regular formation of the sea surface temperature anomalies (SSTA) in the South Eastern Mediterranean Sea.
Time distribution of SSTA values display both positive and negative cycles which are nearly associated with the 11 year cycle of sun-spots activities. Normal SSTA band occupies only 21.41%, while the positive and negative bands occupy 32.90% and 45.69%.
Keywords: Eastern Mediterranean, Temperature

The relationship between sea surface temperature (SST) and atmospheric variables is very important for the formation of the intermediate and deep waters [1-2]. The area of study lies between 30 - 33ºN and 25 - 34ºE. The vertical mean temperature of the upper 10 m layer is considered as sea surface temperature to reduce the diurnal variations. The monthly mean sea surface temperature (T) is calculated for each 1º grid (18 grids, Fig. 1) for every month in the period from April 1948 to August 2008 using the available historical data.

The mean monthly Sea surface temperature is obtained from the Climatological Atlas [3]. The deviation from the mean is computed and considered as monthly SSTA for every grid. The mean monthly positive and negative SSTA through the investigated period are determined, from which the SSTA amplitudes are calculated. The regular formation and evaluation of the SSTA will be studied.

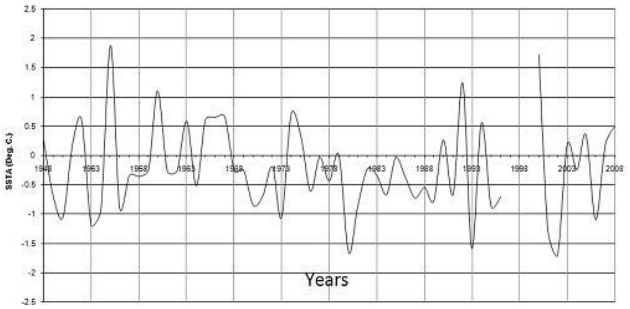


Fig. 1. Mean annual variation of SSTA of the South Eastern Mediterranean Sea.

Spatial and temporal distribution of SSTA
The normal, positive and negative SSTA bands occupy 21.41, 32.90% and 45.69% of the investigated period (Table 1). The negative SSTA is developed in January, June and November. As for positive SSTA, there are one active periods from May to August. The maximum SSTA amplitude occurs in June, which coincided with negative and earlier than positive anomalies. The active period of the SSTA amplitude is extended between May and November.

Tab. 1. The percentage of occurrence of SSTA bands.

SSTA band (°C)	Percentage of occurrence (%)
<-2.0 °C	17.75%
-2.0 = band = -1.0 °C	18.02%
-1.0 = band = -.05 °C	9.92%
-0.5 = band = 0.5 °C (Normal)	21.41%
0.5 = band = 1.0 °C	8.62%
1.0 = band = 2.0 °C	12.79%
band >2.0 °C	11.49%

The high amplitude lies close to land with inverse relation to the shelf width. The low amplitude is centered off the Nile Delta characterized by very wide continental shelf.
The positive SSTA is high in the west and centre decreasing seaward. In the north-east there is an area of high positive anomaly. There are two areas of low positive anomaly coincide with Mersa Matruh and Dammetta anticyclonic gyres [4-5].
The Interannual variability of the anticyclones is the reason of the presence of negative active areas. This conclusion is coinciding with the results of [6-7].

References
1 - Maiyza I.A., (1986). On the peculiar hydrographic character of the Eastern Mediterranean Sea in warm and cold winters. Bull. Inst. Oceanogr. & Fish., A. R. E. 12: 291- 299.
2 - Maiyza I.A., Mohamed E.E., Saad N.N., and Sharaf El-Din S.H., (1995). Sea surface temperature anomalies in the western Mediterranean. IAPSO XXI General assembly, Honolulu, Hawaii, USA, August 5-12, 1995).
3 - Maiyza I.A. Mohamed E.E.,and Badawi H.K.,(1993). Climatological Atlas of the Mediterranean Sea. Bull. Nat. Inst. Ocn. & Fish., A.R.E.,(19): l - Vll.
4 - Abdel-Moati A.R. & Said M.A., (1987). Hydrographic structure of the Mediterranean shelf waters off the Egyptian coast during 1983-1986. Thlassographica 10: 23-39.
5 - Said M.A. & A. M. Karam A.M., (1990). On the formation of the intermediate water masses off the Egyptian Mediterranean coast. Arch. Hydrobiol. 120: 111-122.
6 - Fedrouich L. A., (1985). Regular formation of large scale temperature anomalies of the surface layer in the northern Pacific Ocean. Ph. D. Thesis, Moscow Univ., 24p.
7 - Maiyza I. A., (1984). Long term variation of water temperature in the eastern part of the Mediterranean sea. Ph. D. Thesis, Moscow Univ., 240p (in Russian).

TRANSMISSOMETRY AND LISST MEASUREMENTS DURING SESAME-IP CRUISE IN THE EASTERN MEDITERRANEAN (MARCH-APRIL 2008)

Aristomenis Karageorgis [1]*
[1] Hellenic Centre for Marine Research, Anavissos, Greece - ak@ath.hcmr.gr

Abstract
Light transmission, fluorescence, *in-situ* particle size, and particulate matter concentration were measured during March-April 2008 in 20 stations over the Eastern Mediterranean Sea, as part of the SESAME Project. We present a preliminary assessment of the similarities and differences of the Ionian, Levantine, north Aegean and south Aegean Seas, focusing on the properties of the suspended particles and their spatial distribution patterns.
Keywords: Eastern Mediterranean, Sampling Methods

Introduction
The use of transmissometers is well-known for the study of particle dynamics in the ocean for many decades [1, 2]. However, information regarding *in-situ* particle size spectra, mean grain size, and volume concentration of particles in suspension up to 3000 m depth, can be measured only recently with LISST-Deep (Laser In Situ Scattering and Transmissometry; Sequoia Scientific, Inc. [3]), the only commercially available instrument with such specifications. In the framework of SESAME Integrated Project (Southern European Seas: Assessing and Modelling Ecosystem Changes), a multidisciplinary oceanographic cruise took place in the Eastern Mediterranean, collecting data, among others, on light transmission, fluorescence, particulate matter concentration, and *in-situ* particle size distributions. The aim of this work is to contribute to a better understanding of particle dynamics in different sectors of the Eastern Mediterranean, i.e. the Ionian, Levantine, north Aegean, and south Aegean Seas, and to provide for the first time information on suspended particle size distributions.

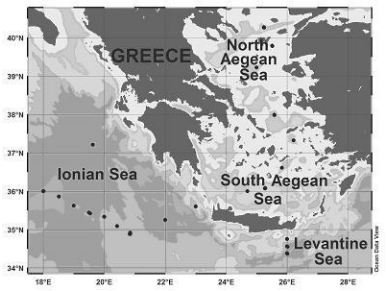


Fig. 1. Sampling stations location map.

Materials and Methods
During the cruise 20 stations were occupied on board the R/V Aegaeo (Fig. 1). Standard CTD measurements were obtained with a Sea-Bird Electronics 11*plus* CTD deck unit interfaced with a Sea-Bird Electronics 9*plus* unit attached to a General Oceanics rosette with 24 Niskin bottles. Light transmission (subsequently converted to beam attenuation coefficient *c*, in m^{-1}) was measured by two 25-cm path-length transmissometers emitting at 470 nm (Chelsea Alphatracka MKII) and 660 nm (Wetlabs C-Star), fluorescence by a fluorimeter (Chelsea Aquatracka III), and particle-size with the autonomous LISST-Deep. All sensors were attached to the lower part of the rosette frame and results refer to the downcasts [4]. The particulate matter concentration (PMC) was determined by on board water filtration of 1 to 10 litres of seawater passed through pre-weighed polycarbonate membrane filters with pore size 0.4 μm; filters were dried and re-weighed upon return to the laboratory (163 samples).

Results and Discussion
Ionian Sea: Beam *c* values vary from 0.384 to 0.503 m^{-1} (mean 0.401 m^{-1}) with noticeable higher values in the upper 150 m. The highest value is recorded near the surface of the westernmost station; however, there is a slight increasing trend towards the east. Fluorescence shows a very clear high concentration zone between 60 and 110 m depth, with maxima at 80 m. This pattern is consistent at all Ionian Sea stations. PMC range is 0.03-0.30 mg l^{-1} (mean 0.12 mg l^{-1}), with relatively higher values appearing at the upper 0-200 m (mean 0.16 mg l^{-1}), demonstrating the general scarcity of suspended particles in the Ionian Sea [5]. Median particle diameter D_{50} measured in 3 stations with LISST varied from 40 to 160 μm, but without any consistent pattern over depth. Records were generally noisy and with a lot of spikes, making the interpretation rather difficult, whereas the distribution of particle volume concentration (*VC*, in μl l^{-1}) looks more reasonable. *Levantine Sea*: Only 3 stations were occupied south of Crete. Beam *c* values vary from 0.406 to 0.521 m^{-1} (mean 0.422 m^{-1}) and they are observed clearly in the zone between the surface and 100 m depth. Fluorescence exhibits maxima around 80 m, with a decreasing trend offshore. PMC (0.06-0.43 mg l^{-1}) shows slightly higher values, similarly to beam *c*, because of the proximity of the stations to the land. D_{50} measured in 2 stations shows a similar behaviour as the previous. Summarizing, the general picture of the Ionian Sea and the Levantine Sea is fairly similar. *North Aegean Sea:* 4 stations occupied. Beam *c* values vary from 0.424 to 0.837 m^{-1} (mean 0.479 m^{-1}). In this area characteristic surface, intermediate, as well as bottom nepheloid layers are observed, demonstrating generally a more turbid environment. Fluorescence values show maxima at 50 m depth and an increasing trend from the north to the south. PMC range is 0.05-0.85 mg l^{-1} (mean 0.20 mg l^{-1}), with higher values appearing clearly at the upper 100 m. LISST measurements are characterized by high variability over depth (D_{50} 30-150 μm). *South Aegean Sea:* Beam *c* values vary from 0.409 to 0.578 m^{-1} (mean 0.444 m^{-1}), with pronounced surface nepheloid layers extending to 150 m depth. Fluorescence maxima appear between 50 and 100 m and decrease toward the open sea (southwards). PMC range is 0.04-0.63 mg l^{-1} (mean 0.22 mg l^{-1}). Similarly to the north Aegean, LISST measurements are not satisfactory.

Conclusions
The Ionian and the Levantine Sea are characterized by extremely particle-free waters throughout the water column, followed by the south Aegean Sea. The north Aegean Sea shows more turbid waters due to rivers inputs. Fluorescence maxima are pronounced but they are observed at different depths. Particle size measurements obtained with LISST are questionable, since they show high fluctuations over depth and also very high D_{50}, which is not expected at such depths. However, the presence of marine snow composed of large aggregates could provide an explanation for the large size classes. On the other hand, the high frequency variability in D_{50} is mostly due to the influence of noise on the measurements because the signal is very low. The main issue is that there are hardly any particles in the water; the volume concentrations from the LISST are well below 1 μl l^{-1} in most cases, and PMC data support this. So this is really pushing the technology to the extreme limits of what is measurable, in terms of light scattering. The overall behaviour of the instrument and its measurements needs careful re-evaluation. Most probably problems arise from the very low PMCs observed in the Eastern Mediterranean.

References
1 - Biscaye P.E. and Eittreim S.L, 1977. Suspended particulate loads and transports in the nepheloid layer of the abyssal Atlantic Ocean. *Mar. Geol.*, 23: 155-172
2 - Gardner W.D., Biscaye P.E., Zaneveld J.R.V. and Richardson M.J., 1985. Calibration and comparison of the LDGO nephelometer and the OSU transmissometer on the Nova Scotian Rise. *Mar. Geol.*, 66: 323-344
3 - Mikkelsen O.A. and Pejrup M., 2000. In situ particle size spectra and density of particle aggregates in a dredging plume. *Mar. Geol.*,170: 443-459.
4 - Bishop J.K.B., 1986. The correction and suspended particulate matter calibration of SeaTech transmissometer data. *Deep-Sea Res.*, 33: 121-134.
5 - Karageorgis A.P., Gardner W.D., Georgopoulos D., Mishonov A.V., Krasakopoulou E. and Anagnostou C., 2008. Particle dynamics in the Eastern Mediterranean Sea: A synthesis based on light transmission, PMC, and POC archives (1991-2001). *Deep-Sea Res. I*, 55(2): 177-202. DOI: 10.1016/j.dsr.2007.11.002

IMPACT OF WINTER COOLING ON THE VARIABILITY OF THERMOHALINE CHRACTERISTICS OF ACTIVE LAYER IN THE BLACK SEA

Alexander S. Kazmin [1], Andrei G. Zatsepin [1]* and Vladimir B. Piotukh [1]
[1] P.P. Shirshov Institute of Oceanology Russian Academy of Sciences, Moscow, Russia - zatsepin@ocean.ru

Abstract
The influence of the winter atmospheric forcing on the inter-annual variability of the Black Sea active layer's thermohaline structure during 1982-2008 is investigated. A high correlation between the variability of the winter-mean sea surface temperature/air temperature and thermohaline characteristics of the active layer during the following warm season was found. It is shown that winter atmospheric forcing significantly affects the variability of both temperature and salinity and density up to 150-200 m depth.
Keywords: Black Sea, Air-Sea Interactions, Hydrography

The response of the marine environment to the long-term variability of the atmospheric forcing is a problem associated with the influence of the climate change on the ecosystem. It is especially important for the Black Sea since its ecosystem is very sensitive to the variability of the thermohaline structure [1, 2]. This variability on scales from synoptic to seasonal is reasonably well established [3, 4]. However, information on the longer-term variability and its connection with the large-scale atmospheric forcing is limited and refers mainly to the sea surface temperature (SST). The first attempts to associate the long-term variability of SST in the Black Sea with the large-scale atmospheric forcing are presented in [5, 6]. The goal of the present study is to investigate the influence of the winter atmospheric forcing on the inter-annual variability of the Black Sea thermohaline structure during 1982-2008. The results are based on a combined analysis of ship hydrological measurements, satellite measurements of the SST and NCEP/NCAR reanalysis data for the surface air temperature (SAT). The preliminary results of our findings may be briefly summarized as follows:

(1) the integral indicators of winter atmospheric forcing are SST (averaged for January to March) or SAT (averaged for December to February). SST and SAT are highly inter-correlated (R=0.92) which means that significantly longer time series of SAT may be used for analysis;

(2) the thermal climatic signal in the active layer is positively correlated with SST and SAT, reaches its maximum at 40-60 m and monotonously falls down with depth. The salinity and density variability is more complicated. They are negatively correlated with SST/SAT up to 80-100 m and change the sign of correlation to opposite at the level of the permanent thermocline. Inter-annual variability of the thermohaline characteristics becomes negligible at the depth of 150-200 m;

(3) an integral indicator of the long-term variability in the active layer of the Black Sea is the mean temperature of the cold intermediate layer (CIL). The CIL mean temperature decreased during 1982-96 and increased for about 0.9 deg.C in 1997-2002, which is consistent with the major climatic events described in [5, 6];

(4) we find out that the heat content deficit in the CIL is spatially inhomogeneous: it is about twice as thicker in the area of the continental slope compared to the deep area due to the specific water circulation;

(5) a statistically significant correlation between the CIL temperature and winter SST/SAT existed for two years. It means that the influence of winter cooling on a given specific year may be traced in the CIL characteristics during at least the two following years.

This work was funded in the frame of bilateral the Russian–Turkish project 'Response of Black and Aegean Seas to climatic variations' (Russian Foundation for Basic Research grant #09-05-91221-CT a) and EU international project "SESAME".

References
1 - Oguz T., Cokacar T., Malanotte-Rizzoli P. and Duclov H.W., 2003. Climatic warming and accompanying changes in the ecological regime of the Black Sea during 1990s. *Global Biogeochem. Cy.*, 17(3): 1088, doi: 10.1029/2003GB002031.
2 - Oguz T., 2005. Black Sea ecosystem response to climatic variations. *Oceanography*, 18(2): 122-133.
3 - Kostianoy A.G. and Kosarev A.N. (Eds.), 2008. The Black Sea Environment. The Handbook of Environmental Chemistry, Vol.5: Water Pollution, Part 5Q. Springer-Verlag, Berlin, Heidelberg, New York, 457 p.
4 - Oguz T., Tugrul S., Kideys A.E., Ediger V. and Kubilay N., 2005. Physical and biogeochemical characteristics of the Black Sea. *The Sea*, 14, Chapter 33: 1331-1369.
5 - Kazmin A.S. and Zatsepin A.G., 2007. Long-term variability of surface temperature in the Black Sea, and its connection with the large-scale atmospheric forcing. *J. Marine Syst.*, 68 (1-2): 293-301, doi: 10.1016/j.jmarsys.2007.01.002.
6 - Kazmin A.S., Zatsepin A.G. and Kontoyianis H., 2009.Comparative analysis of the long-term variability of winter surface temperature in the Black and Aegean Seas during 1982-2004 associated with large scale atmospheric forcing. *Int. J. Climatol.*, doi: 10.1002/joc.1985.

ASSESSMENT OF VERTICAL EDDY DIFFUSIVITIES THROUGH IDENTIFICATION OF POTENTIAL DENSITY OVERTURNS WITHIN THE FRAME OF SESAME PROJECT.

Sotiris Kioroglou [1]*, Vassilis Zervakis [2], Elina Tragou [3] and Emin Özsoy [4]
[1] Hellenic Center for Marine Research, Anavyssos, Greece - skior@ath.hcmr.gr
[2] Deparment of Marine Sciences, University of Aegean, Mytilene, Greece
[3] Department of Marine Sciences, University of the Aegean, Mytilene, Greece
[4] Institute of Marine Sciences, Technical University of Middle East, Erdemli, Turkey

Abstract
In this work, an estimation of vertical eddy diffusivities and dissipation rates for the SESAME cruises is conducted. The method is based on tracing the 'genuine' overturn limits within potential density CTD profiles. The respective algorithm is applied on CTD data of the broader area encompassing the Greek Seas, the Black Sea, the Turkish Straits and Marmara Sea, acquired at 2 seasons (Winter and Summer 2008).
Keywords: Coastal Processes, Aegean Sea, Black Sea, Marmara Sea, Vertical Profile

The identification and vertical extent estimation of 'genuine' vertical overturns has already been used in literature [1, 2, 3] for assessing vertical eddy diffusivities and dissipation rates. Overturns are 'unstable' potential density (p. d) structures, in which heavier water masses temporarily overly lighter ones. Instability will cause the water parcels to move towards restoring a stable, increasing monotonically with depth, p.d profile (when all motions are 'included' within the overturn limits the overturns are referred to in literature as 'complete').

An algorithm has been developed, for tracing all possible complete overturns (by estimating their exact boundary limits) that are (in the form of onedimensional snapshots) part of a CTD measured p.d profile. The algorithm further sorts the traced overturns as 'genuine' or 'artificial', according to the Galbraith and Kelley method [1]. This method disqualifies overturns that are result either of instrumental noise, (being characterized by small on the average populations of spatially subsequent and kinematically correlated particles), or instrumental errors (being characterized by 'non-linear' T-S relation of their water masses). As a final step the algorithm estimates value pairs of vertical eddy diffusivities and dissipation rates, one value pair per overturn, according to turbulent scale analysis.

The algorithm was applied on the available SESAME 1 (Winter 2008) and SESAME2 (Summer - Fall 2008) CTD cruises for the Aegean Sea, the Cretan Sea, the Southern Ionian Sea, the Marmara Sea and the Black Sea, thus enabling both spatial and temporal variation studies. Stations that presented considerable number of overturning events were 'pooled together' in transects, for studying the vertical distribution of 'eddy diffusivities' and correlating turbulent events with local dynamic conditions, if and when possible (Figures 1 and 2).

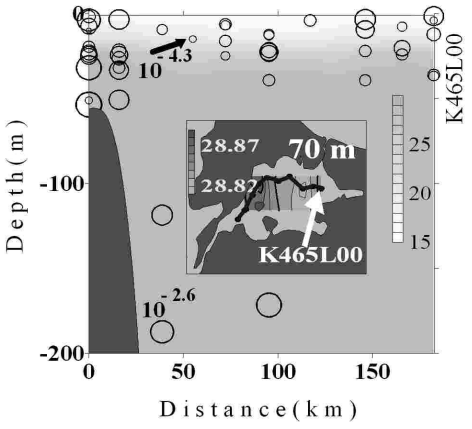


Fig. 1. Vertical distribution of eddy diffusivities (circles) along a transect (drawn in the inlay) in the Sea of Marmara, Turkey, in October 2008 (during the SESAME2-WP3 cruise). The circle sizes are analogous to the log (diffusivities). Overlaid is the vertical potential density (sth) and inlaid the horizontal sth distribution at 70 m.

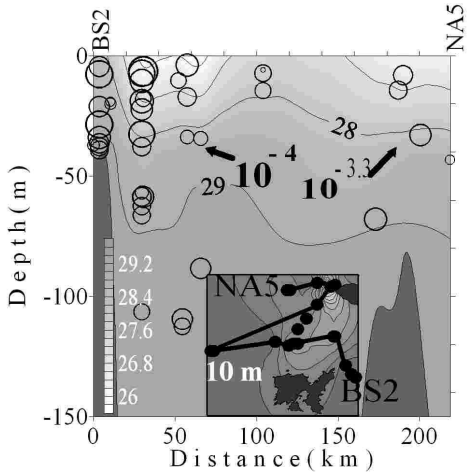


Fig. 2. Vertical distribution of eddy diffusivities (circles) along a transect (transect line is drawn in the inlay) in the North Aegean Sea, North off Lemnos islan, Greece, in April 2008 (during the SESAME1-WP3 cruise). The circle sizes are analogous to the log(diffusivities). Overlaid is the vertical potential density (sth) and inlaid the horizontal sth distribution at 10 m.

Histograms of overturns' frequency of occurence versus eddy diffusivities and dissipation rates showed peaks of highest frequency at 10^{-4} to 10^{-5} m^2 / sec and 10^{-6} to 10^{-7} m^2 / sec^3 for eddy diffusivity and dissipation rates respectively. Higher diffusivity values were observed in North Aegean, where surface Black Sea Water intermingles with subsurface Levantine Water. Higher diffusivity values were also observed in the proximity of the Turkish Straits (Dardanelles, Bosphorus). Most overturns were observed above the thermocline, however intermediate depth (200m to 300m or more) depth overturns were occasionally observed in almost all the study Seas. High resolution CTD data, comprising a dense horizontal grid, prove essential for future vertical diffusion studies. The method however is also valuable for historical diffusion studies.

References
1 - Galbraith P.S. and Kelley D.E., 1996. Identifying overturns in CTD Profiles. *J. Atmos. Ocean. Tech.*, 13: 688-702
2 - Dillon T.M., 1982. Vertical overturns: A comparison of Thorpe and Ozmidov length scales. *J. Geophys. Res.*, 87: 9601-9613.
3 - Stansfield K., Garett C. and Dewey R., 2001. The Probability Distribution of the Thorpe Displacement within Overturns in Juan de Fuca Strait. *J. Phys. Oceanogr.* , 31: 3421 - 3434.

THE STATUS OF THE DEEP HYDROGRAPHY AND EDDY FIELD DURING 2006-2009 AT THE SOUTHEAST IONIAN TENTATIVE NEUTRINO-TELESCOPE SITE

Harilaos Kontoyiannis [1]*

[1] Hellenic Centre for Marine Research, Anavyssos/Athens, Greece - hk@ath.hcmr.gr

Abstract

The deep neutrino-telescope site (NESTOR) in the southeast Ionian Sea is located offshore from the southwest end of the mainland of Greece in the deepest area of the Mediterranean with depths reaching 5.2 km. Among various multidisciplinary observational tasks in the period 2006-2009, long current-meter moorings were deployed and several west-east, normal-to-local-bathymetry hydrographic sections were conducted with main goal to monitor the physical water characteristics and flow conditions. The sections cut through a deep vein at ~3200 m of Cretan water in the southeast Ionian. A weakening in the presence of Cretan water and a tendency for offshore migration of the vein core is observed from 2006 to 2009, while the flow field at depths greater than ~3.5 km is dominated by a cyclonic eddy locked on the local bathymetry.

Keywords: Deep Sea Basins, Ionian Sea, Circulation

Introduction

The role of Physical Oceanography in the development of the appropriate infrastructure for the operation of underwater deep-facilities of neutrino telescopes in the Mediterranean has been to provide the description of the physical water characteristics and flow conditions along with their variability at the selected sites. One tentative site is located in the southeast Ionian Sea offshore from the south-west tip of Peloponissos/ Greece with depths of 4-5 km. This area is not far from the Cretan Straits, where the Cretan water masses outflow into the deep Eastern Mediterranean (Ionian and Levantine Seas). Thus, the involvement of Physical Oceanography in the effort of developing the Mediterranean neutrino telescopes is directly related to the deep thermohaline circulation, spreading and transformation of water mass properties originally generated at their formation regions.

Field Work

Intense observational work has been carried out in the period 2006-2009. A basic effort has been put to monitor the hydrographic conditions along a west-east section on a yearly basis, while additional CTD stations in the near vicinity have allowed to construct maps of dynamic topography showing the localized sub-mesoscale circulation structures. In parallel, long current meter moorings at two sites with bottom depths 4.5 km and 5.2 km have been maintained providing direct current measurements at four levels of the water column (Fig. 1). Unfortunately, in the period 2006-2009 there was no larger-scale hydrographic survey to map the particular meso-scale or sub-basin scale structure(s) in which the transect observations were/are embedded.

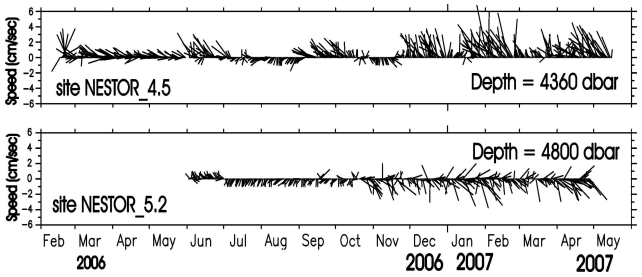


Fig. 1. Time series of deep currents at positions NESTOR_5.2 (36º 32,709' N - 21º 07.231' E) and NESTOR_4.5 (36º 32.822'N - 21º 29.064'E)

Results

A deep vein-like structure with a core at ~3200 m is identified in the transect to the west of Peloponissos. The local salinity maxima at its core indicate a Cretan origin. Below ~3200 m, there exist water masses of recent Adriatic origin, whereas at ~5.2 km there is a low-oxygen, isolated, old Adriatic water mass. Apart from the typical properties of temperature, salinity and dissolved oxygen used to identify and describe these structures, water transparency is also measured in the transects due to its importance in detecting neutrinos. The Adriatic and Cretan water masses do carry a transparency signal, characterizing their origin, with decreasing/increasing transparencies in the Adriatic/Cretan water mass. The core of the Cretan water at ~3200 m is shifting towards the west by ~30 km. In 2009 it loses the vein-like structure in salinity but it consistently preserves its higher transparency core signal in the entire observational period. The overall salinity is decreasing from 2006 to 2009. The deep flow field at depths of 4.5 km and 5 km is characterized by extremely weak velocities with mean speeds near ~2 cm/sec. A cyclonic eddy locked on the local bathymetry appears to exist at depths from ~3.5 km to the bottom in 2006 and 2008. In May 2009, however, its vertical extent is decreased to depths greater than ~4 km.

References

1 - POEM Group, 1992. General Circulation of the Eastern Mediterranean. *Earh Sci Rev*., 32: 285-309.

2 - Beuvier J., F. Sevault, M. Herrmann, H. Kontoyiannis, W. Ludwing, M. Rixen, E. Stanev, K. Beranger, and S. Somot, (2010), Modelling the Mediterranean Sea interannual variability over the last 40 years: Focus on the Eastern Mediterranean transient (EMT) (This Issue)

3 - Malanotte-Rizzoli, P., B. Manca, M. Ribera d'Alcala, A. Theocharis, S. Brenner, S. Budillon, E. Ozsoy, (1999), The Eastern Mediterranean in the 80'2 and 90's: The big transition in the intermediate and deep circulation. Dynamics of Atmospheres and Oceans 29 (2-4), 36-395

4 - Robinson, A., M. Golnaraghi, W. Leslie, A. Artegiani, A. Hecht, E. Lazoni, A. Michelato, E. Samsone, A. Theocharis, and U, Unluata (1991), The Eastern Mediterranean general circulation: features structure and variability. Dynamics of Atmospheres and Oceans15, 215-240.

5 - Theocharis A., B. Klein, K. Nittis W. Roether (2002), Evolution and status of the Eastern Mediterranean Transient (1997-1999), Journal of Marine Systems 33-34, 91-116.

ADVANCES IN THE NORTHEASTERN MEDITERRANEAN SEA: COMPLEX PATHWAYS OF THE WATERS OF BLACK SEA ORIGIN THROUGH THE AEGEAN SEA

Villy Kourafalou [1]*, Kostantinos Tsiaras [2], Dionysios Raitsos [2] and Ioannis Androulidakis [3]
[1] University of Miami, Miami, FL, U.S.A. - vkourafalou@rsmas.miami.edu
[2] Hellenic Center for Marine Research, Anavyssos, Greece
[3] Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract
Recent advances in both observations and modelling have allowed the better understanding of the factors that influence the transport pathways of waters of Black Sea origin and their influence on the Aegean Sea physics and ecosystem over a range of spatial and temporal scales. This study elucidates the related dynamics, focusing on the influence of the biophysical properties of the Dardanelles outflow, atmospheric forcing and the complex topography of the receiving basin on (a) the seasonal and inter-annual variability of observed surface Chlorophyll-a spatial patterns; and (b) long term changes in Sea Surface Temperature and the associated variability in the North Aegean contribution of Eastern Mediterranean dense waters.
Keywords: Continental Shelf, Aegean Sea, Black Sea, Circulation Models, Chlorophyll-a

The outflow of waters of Black Sea origin (BSW) in the Aegean Sea through the Dardanelles Strait is a key mechanism in the coupling of the Mediterranean and Black seas. The low-salinity, nutrient-rich BSW are a key factor in increased biotic productivity for the North Aegean, sustaining one of the most significant fish stocks in the Eastern Mediterranean. They also may influence long term changes in the properties of deep water masses, as they may alter the pre-conditioning for dense water formation.

An international effort has recently focused on the coupling of the two basins, recognizing the key role of the flow exchanges in the Northern Aegean and the Southern Black seas through the Turkish Straits System (TSS: Dardanelles Strait, Sea of Marmara, Bosporous Strait). This effort is a unique collaboration of projects funded by the European Union (SESAME project), the NATO Undersea Research Center (TSS 2008-2009 Sea Trials), the U.S. Naval Research Laboratory (NRL-Stennis Space Center) and the U.S. Office of Naval Research. The coordinated observational and modeling effort is a true breakthrough for the oceanography of this complex region, toward the better understanding of the biophysical dynamics of the coupled Mediterranean and Black Sea system.

This presentation will focus on modeling results, with appropriate examples and references to abstracts that present the analysis of recent observations. Satellite and drifter observations will be employed for model evaluation. In particular, results from two hydrodynamic models (based on the Princeton Ocean Model, POM; and the Hybrid Coordinate Ocean Model, HYCOM) and a coupled hydrodynamic/biogeochemical model (based on POM and the European Regional Seas Ecosystem Model, ERSEM) will be presented. The seasonal variability of BSW pathways will be revealed and the long term (1985-2007) interannual variability of the North Aegean water mass characteristics will be examined and compared against the effects of vertical (atmospheric forcing) and lateral (buoyancy input) fluxes, in an attempt to assess the productivity variability in the N. Aegean over the last decades and identify any possible climatic trends. High frequency/high resolution atmospheric forcing has been used for the 2002-2007 period from the POSEIDON operational atmospheric model [1]. The atmospheric forcing for the 1985-2000 period is based on the ECMWF ERA40 reanalysis [2]. The modelled major events of low Sea Surface Temperature (SST) are in agreement with satellite derived SST and the associated increased dense water formation in the N. Aegean can be connected to the Eastern Mediterranean Transient (EMT, [3,4,5]). This phenomenon of massive dense water formation in the N. Aegean has been attributed to the local atmospheric forcing variability triggering significant buoyancy loss through evaporation, combined to an increased salinity preconditioning induced by a decrease of BSW inflow and/or the increased inflow of Levantine more saline waters [6]. However, the impact of BSW on the preconditioning phase remains unclear.

We also explore and assess the major variables that influence the surface phytoplankton biomass. Temperature, Salinity, Sea Surface Height and Mixed Layer Depth from the two different hydrodynamic models and productivity parameters from the biophysical model have been employed in Generalised Additive Models (GAMs: a flexible regression technique that can model nonlinearities using nonparametric smoothers), to study the contribution of these various physical and ecological factors in the variability of satellite derived Chlorophyll-a, a proxy for BSW influence. The remotely sensed surface Chl-a data were derived from the SeaWiFS sensor, for the period of 2002-2006. Monthly averaged time-series were created from the parameter matrix of both SeaWiFS and the numerical models. The analysis was performed for the whole Northern Aegean Sea and for subdomains in the open sea and over different shelf areas, including regions under the immediate influence of both small (rivers) and large (Dardanelles) buoyant outflows, which provide inputs of high Chl-a content. The GAMs analysis showed that the combined effects of the variables used, explained >80% of the surface Chlorophyll variation. Also it was found that depending on the subarea, the Chl-a was primarily controlled physically rather than chemically (nutrient related) and *vice versa*. As a general rule, higher Chl-a values were associated with lower temperature and salinity values, increasing phosphate and declining nitrate trends. The negative correlation with nitrate indicates that generally the study area is a phosphate limited one. Finally, the influence of cold, nutrient rich, and less saline waters of the Black Sea and/or riverine origin on the observed chl-a patterns, is evident in almost every subarea.

References
1 - Papadopoulos, A., G. Kallos, P. Katsafados and S. Nickovic, 2002. The Poseidon weather forecasting system: An overview. *Global Atmos. Ocean Sys.*, 8 (2-3): 219-237.
2 - Herrmann M. J. and S. Somot, 2008. Relevance of ERA40 dynamical downscaling for modeling deep convection in the Mediterranean Sea, *Geophys. Res. Lett*., 35: L04607.
3 - Roether W, B. Manca, B. Klein, D. Bregant, D. Georgopoulos, V. Beitzel, V. Kovacevic and A. Luchetta, 1996. Recent changes in eastern Mediterranean deep waters. *Science*, 271: 333–335.
4 - Theocharis A, K. Nittis, H. Kontoyiannis, E. Papageorgiou and E. Balopoulos, 1999. Climatic changes in the Aegean Sea influence the eastern Mediterranean thermohaline circulation (1986–1997). *Geophys. Res. Lett.*, 26 (11): 1617–1620.
5 - Zervakis, V., D. Georgopoulos and P.G. Drakopoulos, 2000. The role of the North Aegean in triggering the recent Eastern Mediterranean climate changes. *J. Geophys. Res*., 105: 26,103-26,116.
6 - Zervakis V, Georgopoulos D, A.P. Karageorgis and A. Theocharis. 2004. On the response of the Aegean Sea to climatic variability: a review, *Int. J. Climatol*. 24: 1845–1858.

INVESTIGATING THE CIRCULATION IMPACTS OF THE DARDANELLES FLOW EXCHANGE WITH THE NORTH AEGEAN HYBRID COORDINATE OCEAN MODEL

Villy Kourafalou [1]*, Ioannis Androulidakis [2] and Ioannis Krestenitis [2]
[1] University of Miami, Miami, FL, U.S.A. - vkourafalou@rsmas.miami.edu
[2] Arisotle University of Thessaloniki, Thessaloniki, Greece

Abstract
The outflow of low salinity, eutrophic and cool waters of Black Sea origin (BSW) through the Dardanelles Strait is the strongest buoyant input for the North Aegean Sea. This outflow affects significantly the physical and biological characteristics of the basin, with implications for water mass characteristics and the circulation and biotic production around remote coastal ecosystems. This study focuses on the understanding of the processes that influence the initial ballooning of the Dardanelles outflow and the subsequent transport and fate of BSW through the Northern Aegean Sea. The Hybrid Coordinate Ocean Model (HYCOM) is employed in a methodology to parameterize and simulate the coupling of the Aegean and Black Seas through the Dardanelles Strait.
Keywords: Aegean Sea, Black Sea, Circulation Models, Coastal Processes, Coastal Engineering

The Dardanelles outflow contains waters of Black Sea origin (BSW) that are generally cooler and with higher nutrient content than the oligotrophic Aegean Sea [1]. This allows the outflow to be detected in Sea Surface Temperature (SST) and ocean color imagery. The BSW is also fresher and responsible for the overall lower salinities in the northern Aegean, where the frontal areas are related to the spreading of BSW above the saltier modified Levantine Intermediate Water (LIW); [2,3,4]. The evolution of BSW through the North Aegean Sea resembles that of a buoyant plume, under the influence of atmospheric forcing and further modified by the complex topography. This outflow affects significantly the physical and biological characteristics of the basin, with implications for the circulation and biotic production around remote Aegean coastal ecosystems.

Lagrangian observations [5] have revealed the complexity of the BSW pathways and the modification of flows through interaction with narrow passages and straits, around islands, along the rim of shelf/coastal areas and deep sub-basins. It is the complexity of topography that motivated the employment of the Hybrid Coordinate Ocean Model [6] on the North Aegean (NAEG-HYCOM), to allow suitable transitions of the vertical coordinate system from isopycnal in the deep regions to bottom-following (sigma) and cartesian (z-level) in the shelf and coastal areas.

The NAEG-HYCOM has 1/50° horizontal resolution and 20 hybrid layers in the vertical. The model has been nested within a basin scale, data assimilative model for the Mediterranean Sea (resolution of 1/25°). This study is part of a unique collaboration of projects funded by the European Union (SESAME project), the NATO Undersea Research Center (TSS 2008-2009 Sea Trials), the U.S. Naval Research Laboratory (NRL-Stennis Space Center) and the U.S. Office of Naval Research. The coordinated observational and modeling effort is a true breakthrough for the oceanography of this complex region, toward the better understanding of the biophysical dynamics of the coupled Mediterranean and Black Sea system.

Two types of experiments have been executed in order to elucidate the development and evolution of the Dardanelles buoyant plume, expressed by the initial tendency for ballooning of the outflow and the subsequent formation and variability of the associated rim current. Theory and observations have been employed to evaluate the model results. Several process oriented experiments have isolated and examined each of the distinct physical aspects that affect the North Aegean Sea circulation and mass characteristics. Realistic experiments covering the 2002-2008 period have focused on the interaction of the circulation forcing mechanisms in determining the seasonal and inter-annual variability of the BSW pathways. Sensitivity to the spatial resolution of the atmospheric forcing is revealed through twin experiments with two high-frequency operational atmospheric products, namely the fine scale (1/10 degree) POSEIDON/SKYRON [7] and the coarse scale (1 degree) Navy Operational Global Atmospheric Prediction System (NOGAPS, [8]).

We employ comparisons of the NAEG-HYCOM model and in-situ observations and satellite images to evaluate the river parameterization procedure, the requirements in atmospheric forcing fields and the impact of the parameterization of the coupling between the North Aegean and Black seas through the BSW outflow at Dardanelles. The BSW bulge balooning and several outflow parameters are compared to the findings of [9]. The parameterization of the Dardanelles outflow follows approaches ranging from a river-like buoyant discharge to a two-layer inflow-outflow system, to coupling with an unstructured grid model of the Turkish Straits System (Dardanelles Strait-Sea of Marmara-Bosphorous Strait), suitable to employ updated time series of measured flow properties.

References
1 - Siokou-Frangou, I., M. Bianchi, U. Christaki, E. Christou, A Giannakourou, O. Gotsis, L. Ignatiades, K. Pagou, P. Pitta, S. Psarra, E. Souvermetzoglou, F. Van Wambeke, and V. Zervakis, 2002. Carbon flow in the planktonic food web along a gradient of oligotrophy in the Aegean Sea (Mediterranean Sea) *J. Mar. Sys.*, 33-34: 335-353.
2 - Zodiatis, G. and E. Balopoulos, 1993. Structure and characteristics of fronts in the North Aegean Sea. *Boll. Oceanol. Theor. Appl.*, XI: 113-124.
3 - Kourafalou, V. H. and K. Barbopoulos, 2003. High-resolution simulations on the North Aegean Sea seasonal circulation. *Ann. Geophys.*, 21: 251-265.
4 - Kourafalou, V.H. and K.P. Tsiaras, 2007. A nested circulation model for the North Aegean Sea. *Ocean Sci.*, 3: 1-16.
5 - Olson, D.B., V.H. Kourafalou, W.H. Johns, G. Samuels and M. Veneziani, 2007. Aegean Surface Circulation from a Satellite-tracked Drifter Array. *J. Phys. Oceanogr*, 37(7): 1898-1917.
6 - Bleck, R., 2002. An oceanic circulation model framed in hybrid isopycnic-Cartesian coordinates. *Ocean Modelling*, 37: 55-88.
7 - Papadopoulos, A., G. Kallos, P. Katsafados and S. Nickovic, 2002. The Poseidon weather forecasting system: An overview. *The Global Atmosphere and Ocean Systems*, 8(2-3): 219-237.
8 - Hogan, T.F. and T.E. Rosemond, 1991. The description of the Navy Operational Global Atmospheric Prediction System. *Mon. Wea. Rev.*, 119:1786–1815.
9 - Nof, D. and T. Pichevin, 2001. The ballooning of outflows. *J. Phys. Oceanogr.*, 31: 3045-3058.

OCEANOGRAHIC PROPERTIES IN THE IONIAN SEA IN WINTER AND SUMMER 2008

V. Kovacevic [1]*, M. Burca [1], L. Ursella [1], S. Kioroglou [2], C. Kontoyiannis [2], D. Georgopoulos [2] and A. Schirone [3]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, 34010, Trieste, Italy - vkovacevic@ogs.trieste.it
[2] Hellenic Centre for Marine Research, Institute of Oceanography, 19013, Anavyssos, Greece
[3] E.N.E.A. (Italian Agency for New Technology, Energy and Environment). 00196, Rome, Italy

Abstract
The state of the art of the oceanographic properties in 2008 of the Ionian Sea is derived from the data sets collected during two campaigns in the framework of the SESAME project. The physical characteristics of the main water masses present in the basin and their seasonal differences are described. The long-term changes in the deep water in the central Ionain Sea are traced by the use of the ^{137}Cs content and associated with a change of the thermohaline properties in the last two decades.
Keywords: Ionian Sea, Density, Salinity, Temperature

Surface dynamical features characteristic of the Ionian Sea area are described by means of satellite altimetric imagery (absolute dynamic topography; http:// www.aviso.oceanobs.com/en/data/product-information/duacs/index.html). They are compared to the subsurface current field measured by a vessel-mounted Acoustic Doppler Current Profiler along the track of the research vessel. The Ionian basin is characterised by the overall anti-cyclonic surface circulation at surface, within which a number of sub-basin and meso-scale gyres and eddies, both clock-wise and anti-clockwise are imbedded. The most persistent is the Pelops anti-cyclonic gyre. These structures influence the distribution and the pathways of the surface and intermediate water masses (Ionian Surface Water, Atlantic Water, and Levantine Intermediate Water, in particular). During winter the upper layer is relatively well mixed. The Atlantic Water (salinity 38.4) is confined to the western portion of the W-E section from the surface down to 100 m (Fig. 1). Levantine Intermediate Water (salinity > 38.9) spreads westward from the eastern Ionian in the layer 150-500 m.

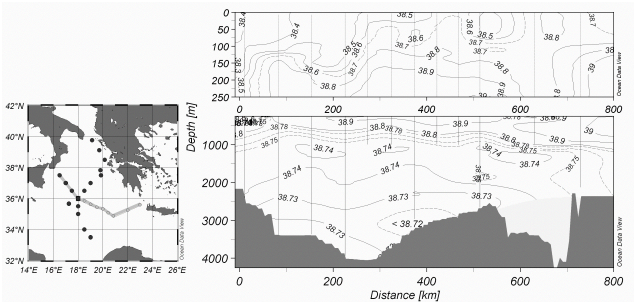


Fig. 1. Vertical distribution of salinity along the W-E section in winter 2008. A rectangular area in the inserted map indicates the central Ionian station.

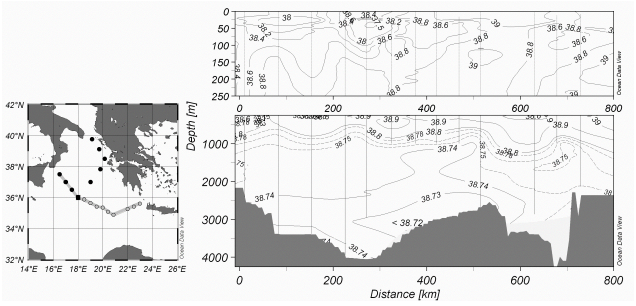


Fig. 2. Vertical distribution of salinity along the W-E section in summer 2008. A rectangular area in the inserted map indicates the central Ionian station.

In summer (Fig. 2), stratification in the upper layer and the sub-basin scale eddies influence the recirculation of the Atlantic Water (minimum salinity < 38 in the 30-50 m layer below the surface), while the Levantine Intermediate Water is down-welled by the Pelops anticyclone. Below the Transitional Mediterranean Water (characterized by an oxygen minimum at around 1000 m) the deepest zones to the west and in the central Ionian are filled with the dense waters (Eastern Mediterranean Deep Water, EMDW) of Adriatic origin (salinity 38.74), while to the east less saline dense waters reside. The most recent EMDW (of Adriatic origin) has higher salinity and temperature values. The present state is compared to changes in the central Ionian Sea during the last two decades [1], and illustrated also by the uplifting of the old bottom waters (detected by means of the ^{137}Cs content).

References
1 - Manca B.B., Budillon G., Scarazzato P., and Ursella L., 2003. Evolution of dynamics in the eastern Mediterranean affecting water mass structures and properties in the Ionian and Adriatic Seas. *J. Geophys. Res,*, 108, C9, doi: 10.1029/202JC001664.

TWO DIFFERENTS NORTHERN ADRIATIC WINTER OCEANOGRAPHIC TYPES

Romina Kraus [1]*, Tamara Djakovac [1], Robert Precali [1] and Nastjenjka Supic [1]
[1] Ruder Boškovic Institute, Center for Marine Research, 52210, Rovinj, Croatia - kraus@cim.irb.hr

Abstract
It has been observed that two types (A and B) of winter oceanographic conditions can occur in the northern Adriatic. The difference between the eastern and western parts bottom layer density distinguishes the two winter types. We intend to present a precise definition of the two types and introduce a third winter type (C). A and B types differ in hydrographic (temperature and salinity), dynamic (geostrophic currents distributions), chemical (total inorganic nitrogen and phosphorous) and biological (phytoplankton) parameters.
Keywords: Adriatic Sea, Circulation, Nutrients, Phytoplankton, Po Delta

Introduction
The northern part of the Adriatic is under the influence of the Po River, one of the largest Mediterranean rivers. Spreading of the Po River waters highly influences oceanographic processes in this region. Depending on circulation patterns, Po River waters are drawn into the northern Adriatic region or are diverted southwards (Figure 1). According to Supic and Vilibic [1], who described winter hydrographic conditions in the northern Adriatic for the 1966-2000 period, two basic hydrographic February conditions (A and B) can occur in the region. The A type occurs when bottom density is higher in the eastern part than in the western one of the northern Adriatic and the B type is when it is just the opposite. A detailed analysis of the two types was needed.

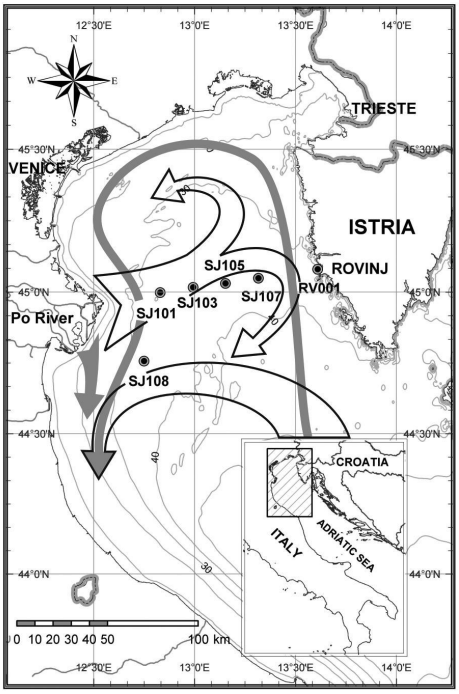


Fig. 1. Northern Adriatic map and schematics of two circulation types in its surface layer. The "open" circulation pattern (solid arrows) favors the inflow of southern Adriatic waters, and the "closed" circulation pattern (open arrows) spreads the Po River waters towards the east.

Methods
Sampling strategy, parameters determination and calculation

Hydrographic (temperature, salinity and density), dynamic (geostrophic currents relative to 30 m depth between each two neighboring stations), chemical (total inorganic nitrogen and phosphorous) and biological (microphytoplankton) samples were collected in February at six stations between the Po River delta (Italy) and Rovinj (Croatia) (Figure 1) in the 1981-2007 period. The parameters were determined by standard oceanographic methods.

Type determination

The A or B type occurs when average 30 m sigma-t value at western stations SJ108 and SJ101 (Table 1) is at least 0.1 lower or higher than at eastern SJ107, respectively. The special C type occurs when the difference is less than 0.1.

Results
In type A winters temperature, nutrient concentrations and phytoplankton abundance at the entire Po River delta - Rovinj transect were generally higher than in type B winters, while salinity and density were lower (Table 1). The difference in phytoplankton abundances between A and B types for the eastern part of the transect was especially pronounced (Table 1).

Tab. 1. Bottom density of the western (W) and eastern (E) northern Adriatic (bottom ρ), the corresponding winter type, surface geostrophic currents relative to 30 m between SJ105 and SJ107 (v; + means flow towards north, and - means flow towards south), intensity of the Po River flow during January and February compared to long-term means (Po flow) and water column averages for temperature (T), salinity (S), density (ρ), orthophosphate (P), total inorganic nitrogen (N; nitrite, nitrate and ammonium) and phytoplankton (phyto; 20-200μm)

Year	Bottom ρ (-1)		Winter type	v (cm s^{-1})	Po flow	Water column averages											
						T (°C)		S (-1)		ρ (-1)		P (μmol L^{-1})		N (μmol L^{-1})		Phyto (cells L^{-1})	
	West	East				W	E	W	E	W	E	W	E	W	E	W	E
1993	29.0	29.2	A	-3	L	8,3	9,3	36,7	37,6	28,6	29,1	0,06	0,03	5,7	2,0	2.488.435	1.618.318
2001	28.7	29.0	A	-1	H	11,3	12,0	37,5	38,0	28,6	29,0	0,16	0,03	5,3	2,7	552.410	208.707
2004	29.6	29.7	A	-10	L	8,8	8,4	36,7	36,8	28,5	28,6	0,05	0,06	6,5	5,4	891.176	1.832.672
2007	29.0	29.1	A	0	L	11,5	11,8	37,8	38,1	28,8	29,1	0,06	0,02	2,9	1,7	112.079	7.030
AVG	**29.1**	**29.3**	**A**	**-4**	**-**	**10,0**	**10,4**	**37,2**	**37,6**	**28,6**	**29,0**	**0,08**	**0,04**	**5,1**	**3,0**	**1.011.025**	**916.182**
1987	29.8	29.5	B	1	L	7,8	8,7	38,0	37,9	29,6	29,5	0,17	0,01	1,5	1,8	-	-
1990	29.6	29.2	B	3	L	9,9	10,4	38,3	38,1	29,5	29,3	0,08	0,01	1,7	1,1	15.417	4.533
1991	29.9	29.8	B	0	L	7,8	8,7	37,3	38,3	29,2	29,7	0,03	0,00	3,9	2,1	2.555.621	5.858
1994	29.5	29.2	B	2	H	9,1	10,2	37,8	37,9	29,3	29,2	0,06	0,00	2,9	1,3	2.780	33.252
1999	29.8	29.6	B	3	L	8,5	8,9	38,2	38,2	29,7	29,8	0,08	0,03	1,4	1,1	202.822	9.898
2000	29.9	29.6	B	1	L	8,4	9,1	38,0	38,2	29,8	29,7	0,05	0,01	2,4	1,0	1.201.020	19.519
2003	29.7	29.6	B	0	H	8,2	8,8	38,2	38,1	29,7	29,8	0,07	0,04	1,8	2,1	4.024	5.010
2005	29.9	29.6	B	4	L	-	-	-	-	-	-	0,05	0,04	2,9	2,8	10.684	589.760
2006	29.9	29.7	B	3	L	7,9	8,5	38,2	38,3	29,8	29,8	0,08	0,04	2,3	2,2	262.762	40.738
AVG	**29.8**	**29.5**	**B**	**2**	**-**	**8,5**	**9,2**	**38,0**	**38,1**	**29,6**	**29,6**	**0,07**	**0,02**	**2,3**	**1,7**	**531.891**	**88.449**
1981	29.8	29.8	C	0	L	8,4	8,6	38,3	38,3	29,8	29,8	0,04	0,02	1,0	0,9	-	-
1982	29.4	29.4	C	3	L	9,0	9,2	37,4	37,6	29,0	29,1	-	-	-	-	5.966.959	853.775
1995	29.2	29.2	C	0	H/L	9,4	10,1	37,6	37,9	29,1	29,2	0,11	0,05	2,2	1,8	578803	2523
1998	29.1	29.1	C	-6	L	9,8	10,0	36,9	37,1	28,5	28,6	0,08	0,01	2,4	1,6	450.596	349.989
AVG	**29.4**	**29.4**	**C**	**-1**	**-**	**9,2**	**9,8**	**37,6**	**37,7**	**29,1**	**29,2**	**0,08**	**0,03**	**1,9**	**1,4**	**2.332.120**	**402.096**

In winters of A type (except in 2007, when currents were very weak) there was a geostrophic flow towards south between stations SJ105 and SJ107, indicating the presence of a large anticyclonic gyre off the Po River delta and spreading of Po waters towards east (Table 1, Figure 1). On the contrary, in winters of B type a geostrophic flow towards north between stations SJ105 and SJ107 was observed. Results of an analysis of winter circulation fields (in preparation) show that the distribution of surface geostrophic currents in winter strongly depends on bottom density distribution. Winter types occur independently of the Po River input (Table 1). Values obtained for all parameters during C type winters are generally between values characteristic for A and B type ones.

Conclusion
Results strongly indicate that in A type winters Po River waters spread over the northern Adriatic, distributing fresh nutrient rich waters towards east and favoring phytoplankton blooms over a large area. In winters of B type, these waters are restricted to the western area. C type winters are more vague and cannot be described as precisely as A and B type winters.

References
1 - Supic N. and Vilibic I., 2006. Dense water characteristics in the northern Adriatic in the 1967-2000 interval with respect to surface fluxes and Po river discharge rates. *Estua. Coast. Shelf. Sci.*, 66: 580-593.

SUB-MESOSCALE WATER DYNAMICS AT THE NARROW BLACK SEA SHELF: PHYSICAL MECHANISMS.

Viacheslav Kremenetskiy [1]* and Andrei Zatsepin [1]
[1] P.P. Shirshov Institute of Oceanology, Moscow, Russia - sk@ocean.ru

Abstract
Using traditional and modern observational methods, the investigations of short-term variability of hydrophysical structure and water dynamics in the Black Sea over the shelf and upper part of continental slope near Gelendzhik were carried out during 3 years (2006-2008). The methods include: a) an analysis of satellite images (sea surface temperature and color); b) sea-going transects at shelf-deep sea area with frequent CTD-profiling; c) quasi-instantaneous surveys (snapshots) with measurements of velocity field by means of towed ADCP. The activities were fulfilled predominantly in autumn season under the conditions of well-developed mesoscale water circulation in north-eastern part of Black Sea and non-stationary wind forcing.
Keywords: Black Sea, Continental Shelf, Coastal Processes, Continental Slope

Sub-mesoscale (1-10 km) and short-term (1-100 hours) variability of the hydrophysical structure and fluid dynamics at the narrow Black Sea shelf depends on a number of factors: wind forcing, fresh water runoff, fluid dynamics over the continental slope and deep part of the sea, coast relief and bottom topography. The influence of the mentioned factors on the shelf fluid dynamics and cross-shelf exchange processes (that are responsible for shelf water renewal and self-purification from natural and anthropogenic pollution) is not well studied. In this paper we present the results of an investigation on the Black Sea shelf fluid dynamics and its short-term and sub-mesoscale variability under the influence of water dynamics over the continental slope and deep sea as well as coast relief and bottom topography.

The study was fulfilled in Gelendzhik area at autumn seasons of 2006-2009. Following data, methods and equipment were used:

1) NOAA, MODIS-AQUA and MODIS-TERRA satellite information (sea surface temperature, chlorophyll "a", water leaving radiance);
2) cross-shelf CTD sections;
3) towed ADCP surveys with sub-mesoscale resolution;
4) bottom mounted ADCP measurements at selected stations.

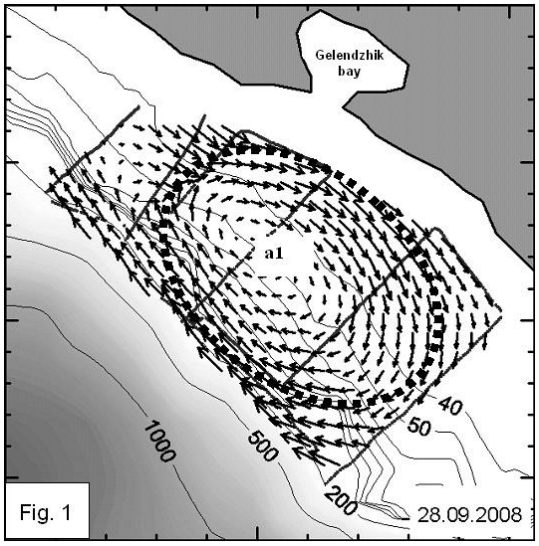


Fig. 1. Anticyclonic sub-mesoscale eddy over the Black Sea shelf, revealed during a towed ADCP survey.

A well-pronounced short-term and sub-mesoscale variability of the fluid dynamics over the shelf and upper continental slope was revealed. Particularly the dynamical variability was characterized by an inconstancy of the alongshore and cross-shore velocity components accompanied by intensive cross-shelf water exchange. The general origin of the observed variability was related to the formation and along-shore transfer of sub-mesoscale eddies with diameter about 5-10 km (Fig. 1).

These eddies were ageostrophic and their life-time normally did not exceed a few days. The main energy source of sub-mesoscale eddy formation was the external circulation – currents over the continental slope. Two basic physical mechanisms of sub-mesoscale eddy formation were revealed. The first was the shear instability of the along-shore current. The second was observed only in case of strong external circulation (when along-shore current velocity over the shelf edge exceeded 40-50 cm/s) and consisted in periodic eddy formation in the concave forms of the coast relief, their detachment from the shore and inclusion to the along-shore current. Some eddies grow up rapidly and transform to mesoscale (geostrophic balanced) eddies, that play an important role in cross-shelf water exchange and influence on the ecosystem of Black Sea coastal zone [1].

This study was supported by the EC IP SESAME, RFBR grants 08-05-00183, 08-05-0063, 09-05-90175, 09-05-13527, 09-05-574.

References

1 - Arashkevich E., Timonin A.G., Zatsepin A.G., Kremenetskiy V.V. and Drits A.V., 2005. Effect of the Rim current regime on the zooplankton distribution in the "shelf – slope – deep sea" system in the Black Sea. *Oceanology*, 45 (Suppl. 1): 149-160.

MODELLING IN A PERPETUAL MODE THE MEDITERRANEAN CIRCULATION USING ATMOSPHERIC FIELDS AT DIFFERENT SPACE-TIME RESOLUTIONS

Cindy Lebeaupin Brossier [1]*, Karine Béranger [2] and Philippe Drobinski [1]
[1] Laboratoire de Météorologie Dynamique, Palaiseau, France - cindy.lebeaupin@lmd.polytechnique.fr
[2] Ecole Nationale Supérieure de Techniques Avancées - ParisTech, Palaiseau, France

Abstract

This paper presents a sensitivity study in regional air-sea numerical modelling. The NEMO-MED12 ocean model is driven by different forcing fields coming from the WRF atmospheric model. We examine here the modifications in the thermohaline circulation and in the small scale ocean response especially under intense meteorological events, when varying the temporal resolution or the spatial resolution of the atmospheric forcing.
Keywords: Models, Atmospheric Input, Air-Sea Interactions, Gulf Of Lions

The Mediterranean Sea circulation with its complex patterns is sensitive to the regional climate [1] and to local extreme meteorological events that frequently occurred over the region. In the framework of the MORCE-MED project, a two-way ocean-atmosphere coupling is developed between the WRF atmospheric model [2] and the NEMO-MED12 ocean model [3]. The future ocean-atmosphere coupled system is part of the future regional numerical platform including also the modelling of the continental superficial layers, atmospheric chemistry and marine biogeochemistry. The whole regional coupled model aims to study the impacts of the climate change over the Mediterranean basin. Before applying the full two-way interactive coupling between the two regional models, the forcing mode is considered through a sensitivity study.

The downscaling of the NCEP reanalyses over the full Mediterranean basin with a 20-km resolution has been done with WRF between August 1998 and July 1999. The WRF model is able to well represent the Mediterranean climate and annual heat and freshwater budgets (Fig. 1), and with a good representation of extreme meteorological events such as strong local winds or heavy precipitation.

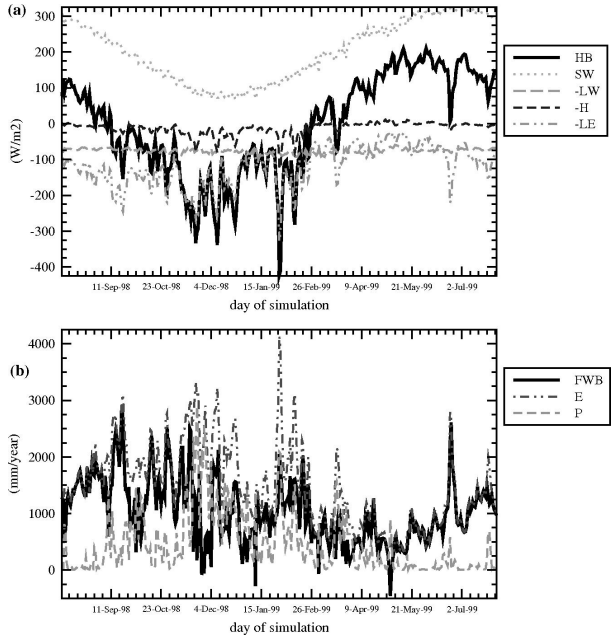


Fig. 1. (a) Heat and (b) freshwater budgets over the Mediterranean [HB (W/m^2)= SW (short-wave radiation -LW (long-wave radiation) -H (sensible heat flux) -LE (latent heat flux); FWB (mm/year)= E (evaporation) -P (precipitation)] according to the daily-averaged WRF simulation fields at 20-km resolution between the 1-Aug-1998 and the 31-July-1999.

The daily atmospheric fields obtained are then used to drive the MED12 ocean model (6-8 km resolution) in a perpetual mode during a spin-up of 8 years. Then, four experiments are done for a period of 4 years. The first experiment (or control experiment CTL) is the continuity of the spin-up. In the second experiment (ZOOMGOL), a finer spatial resolution is applied over the Gulf of Lions area in order to better represent atmospheric mesocale patterns, in particular the channelling of the mistral and tramontane. In the third experiment (3HFREQ), a higher temporal resolution is used, i. e. the frequency of the forcing is 3 hours, allowing a good representation of the diurnal cycle and of the extreme air-sea exchanges during severe meteorological events. Finally, the fourth simulation (HIGHRES) combines the high temporal frequency and the zoomed forcing fields over the Gulf of Lions.

Even if few differences are found between the four MED12 experiments at the basin scale, the local effects of increasing the space-time resolution are significant. The better representation of the mistral/tramontane channelling and acceleration in the zoom modifies the ocean response over the Western basin. Some convective chimneys persist in the Gulf of Lions a few days later than in the control experiment (Fig. 2). The diurnal cycle limits in some extent the surface seasonal warming/cooling, and modifies also the deep convection (Fig. 2); The intense and short-range peaks in the precipitation rate or in the wind stress locally modify the ocean freshening and/or cooling. This results confirm the conclusions already discussed using a 1D ocean model [4].

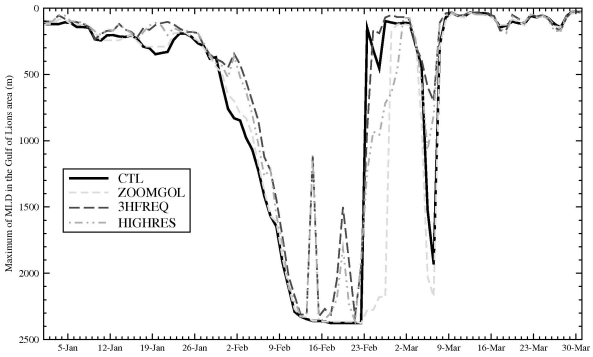


Fig. 2. Evolution of the maximal mixed layer depth (MLD- meters) in the Gulf of Lions area during winter of year 12, for the four experiments.

References

1 - Somot S., Sevault F. and Déqué M., 2006. Transient climate change scenario simulation of the simulation of the Mediterranean Sea for the 21st century using a high-resolution ocean circulation model, *Climate Dynamics*, 27 (7-8): 851-879.

2 - Skamarock W. C., Klemp J. B., Dudhia J., Gill D. O., Barker D. M., Duda M. G., Huang X.-Y., Wang W. and Powers J. G., 2008. A description of the Advanced Research WRF Version 3, *NCAR Tech. Note NCAR/TN-475+STR*: 125pp.

3 - Madec G., 2008. NEMO ocean engine, *Note du Pole de modélisation, Institut Pierre-Simon Laplace (IPSL) France*, No 27 ISSN No 1288-1619.

4 - Lebeaupin Brossier C., Ducrocq V. and Giordani H., 2009. Effects of the air-sea coupling time frequency on the ocean response during Mediterranean intenses events, *Ocean Dyn.*, 59 (4): 539-549.

MONTHLY AND SEASONAL OSCILLATIONS OF THE EASTERN ADRIATIC CURRENT

N. Leder [1]*, N. Domijan [1], Z. Grzetic [1], H. Mihanovic [1] and M. Mlinar [1]
[1] Hydrographic Institute of the Republic of Croatia, Split, Croatia - nenad.leder@hhi.hr

Abstract
Long-term ADCP measurements were carried out between November 2007 and December 2008 along the Croatian internal and territorial waters. Preliminary results of monthly and seasonal oscillations of the Eastern Adriatic Current are presented.
Keywords: Adriatic Sea, Currents, Circulation

Introduction
The Eastern Adriatic Current (EAC) is a branch of the general Adriatic cyclonic circulation along the eastern part of the Adriatic Sea with predominant NW direction. It is well known that EAC varies seasonally, being strongest in winter and weakest in summer [1]. In 2007 the scientific and research program – „The Adriatic Sea Monitoring Program" was implemented. Part of this program consisted on current measurements along the Croatian internal and territorial waters, during a year long period. The measurements started in November 2007 and finished in December 2008. They represent a novel contribution to Croatian physical oceanography, incorporating the greatest number of stations up to date, as well as providing the longest time-series available.

Materials and methods
During the first 6 months current measurements were performed at 20 current meter stations: S01 to S20 (Fig. 1), and in the next 6 months at other 20 current meter stations: S01 to S05, S08 to S14, S16, S18, S20 and S21 to S25 (not shown in Fig. 1). For the first time a large number of long current time-series (forty time series with six-months of measurements) was obtained simultaneously by using ADCP current meters with a sampling interval of 15 minutes and 2 m vertical resolution. Basic statistical analysis of current flow and spectral analysis of currents at all stations were applied. Monthly and seasonal oscillations of the current field were obtained through calculation of the monthly current vectors.

Results and discussion
The spectral analysis of currents showed that energy distribution, depending on the frequency, differed at all stations in both measurement periods. This leads to the conclusion that acting forces in individual sea areas occur with completely different intensities. In the current spectra, gradient currents most frequently have maximum energies, while wind and tidal oscillation energies are somewhat weaker. Some other phenomena and processes, such as fundamental Adriatic seiches and inertial oscillations [2], were also observed in the current spectra. The analysis of measurements shows a general NW circulation (Fig. 1) along the Croatian Adriatic coast – the well known Eastern Adriatic Current (EAC). The resulting circulation may be explained as a modification of the long-periodic gradient currents through the permanent influence of tidal oscillations and wind, while seiches and inertial oscillations are transient. The maximum current speeds were within a range of 55 to 80 cm/s in the surface layer, and from 20 to 30 cm/s in the bottom layer (depending on the station's depth). The absolute current speed maximum of 102 cm/s was measured at station S03 near Rt Kamenjak cape, which is very close to the extreme current speeds recorded in the Adriatic Sea. Mean monthly current speeds were mostly between 5 and 15 cm/s, and usually below 5 cm/s in the bottom layer. Very intense current oscillations were recorded at the seasonal and monthly period at all stations. Generally, that circulation is stronger in the autumn and winter (cold seasons) than during the spring and summer (warm seasons), but there are also exceptions to this general rule. The strongest circulation was observed in February (Fig. 1), and the weakest in August, which matches the present understanding of seasonal sea current oscillations along the eastern Adriatic coast [1]. In February 2008, the circulation matched with the already well-known NW circulation along this coast (Fig. 1). The dominant NW circulation was deformed in some sea areas by the direction of the shore or channel. The circulation was barotropic, which is typical for the winter season. The strongest surface circulation was recorded at S03 (Rt Kamenjak cape) and S11 (open sea in front of the Šibenik archipelago), where the mean monthly current vector was around 12.5 cm/s and the stability factor around 70%. Bottom circulation was significantly weaker, mostly under 5 cm/s. It is important to stress that the circulation at S01 and S02 was in an opposite direction, so that it may be assumed that there was a cyclonic eddy in the northernmost part of the Adriatic [3]. Generally speaking, the weakest circulation was recorded in August 2008, when the mean speeds of the surface monthly current vectors were under 5 cm/s, and those at the bottom were under 2 cm/s. The circulation was baroclinic due to the presence of the strong pycnocline. It appears that in August 2008 two eddies were present in the northern Adriatic: a cyclonic eddy north of the Po-Rovinj joining line and an anticyclonic eddy south of the same line, with the presence of the Istrian Coastal Countercurrent (ICCC) south-west of Rovinj [3].

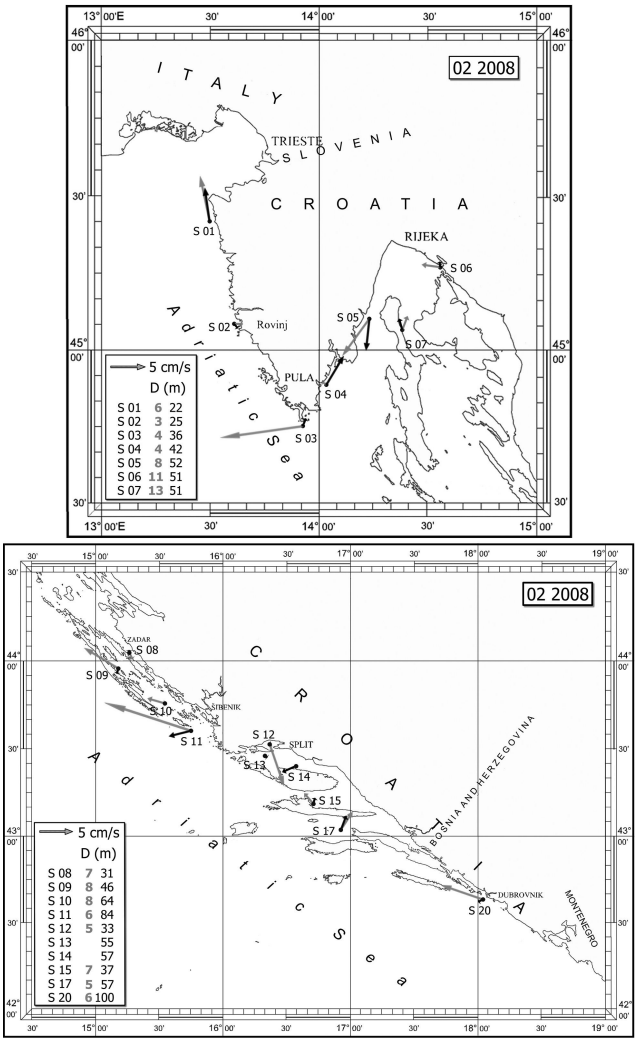


Fig. 1. Monthly mean currents for February 2008 for the subsurface (gray) and near-bottom (black) layer, in the northern Adriatic (top) and middle and south Adriatic (bottom).

Acknowledgements: This program was financed by the funds of the Croatian Ministry of Environmental Protection, Physical Planning and Construction and by a loan from the IBRD (World Bank).

References
1 - Cushman-Roisin B., Gacic, M., Poulain, P.-M. and Artegiani, A. (eds), 2001. Physical Oceanography of the Adriatic Sea. Kluwer, Dordrecht, 304 p.
2 - Leder, N. and Orlic, M., 2004. Fundamental Adriatic seiche recorded by current meters. *Ann. Geophys.*, 22: 1449-1464.
3 - Supic, N., Orlic, M. and Degobbis, D., 2003. Istrian Coastal Countercurrent in the year 1997. *Nuovo Cimento*, C 26: 117-131.

EVOLUTION OF SURFACE WAVE SPECTRA IN EXTREME SEA STATES ALONG THE EASTERN ADRIATIC OPEN SEA AND CHANNEL AREAS

N. Leder [1]*, V. Androcec [2], S. Cupic [1], N. Domijan [1] and G. Loncar [2]
[1] Hydrographic Institute of the Republic of Croatia, Split, Croatia - nenad.leder@hhi.hr
[2] Faculty of Civil Engineering, University of Zagreb, Zagreb, Croatia

Abstract
Measurements of the wind-generated surface waves along the eastern part of the Adriatic Sea in coastal areas are rare; most earlier measurements have been carried out in the open sea. As a part of the scientific and research program – „The Adriatic Sea Monitoring Program", long-term wave measurements were carried out between November 2007 and December 2008 at two stations: in the open sea north area (V1) and in the channel area of the middle Adriatic (V2). Spectral characteristics of waves in extreme sea states are presented and compared.
Keywords: Adriatic Sea, Waves

Introduction
The process of formation and development of surface waves may be considered as a function of three basic variables: wind direction and speed, fetch over which the wind blows and duration of wind of a particular direction. Occurrence of a fully developed model of wind waves is unusual in the Adriatic, which is a semi-enclosed sea of limited fetches. However, instrumental measurements and visual onboard observations of surface wave elements show that during strong gale force winds of longer fetches (SE, W, SW and NE) wave models of respectable dimensions may be developed in the Adriatic Sea. Absolute maximum of wave height H_{max}=10.8 m was measured in the north (V1) and extreme expected value of Adriatic wave height is about 14 m [1].

Materials and methods
Wind generated surface waves were measured at V1 (φ=44°44.5' N; λ=3°10.2' E) in the open part of the north Adriatic and in the Bracki Channel area of the middle Adriatic at V2 (φ=43°29.3' N; λ=16°27.9' E; Fig.1).

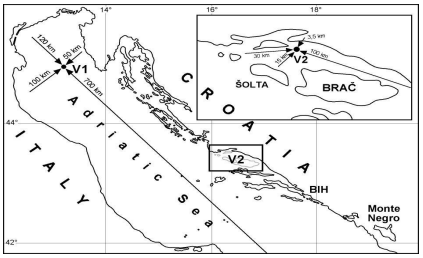


Fig. 1. Location of waverider stations: V1 in the open part of the north Adriatic and V2 in the Bracki channel.

This was undertaken in the time interval from 11.2007 to 12.2008, by using Datawell waveriders with all its components. For the analysis and description of extreme sea states maximum recorded wave height H_{max} and significant wave height $H_{1/3}$ and associated wave spectra will be presented.

Results and discussion
The measurement results show that much larger waves appear in the northern Adriatic compared to the middle Adriatic channel area. This is attributed to a significantly larger fetch of predominant winds in the north (Fig. 1). The maximum wave height of 7.27 m, which corresponds to significant wave height of 4.22 m, was measured at V1 on 10.12.2008. At V2, significantly smaller values were measured, with a maximum wave height of 2.84 m (3.12.2007), which corresponds to significant wave height of 0.92 m. The spectral characteristics of extreme surface waves at V1 are very similar to the observed wave spectra for the open sea [2, 3]. Fig. 2 shows the density spectrum of energy of surface waves for strong and gale southeasterly wind (Scirocco) in V1 on 10.12.2008 when the maximum measured wave height was 7.27 m. It is clear that the maximum density spectrum of energy S(f)=42.52 m^2/Hz corresponds to wave period of 9.1 s, matching the significant wave height $H_{1/3}$=3.75 m. The figure also shows the evolution of the spectrum for the period of increase of energy up to maximum (Fig. 2a) and for the period of decrease of energy (Fig. 2b). During the period of increasing wind speed, an increase of wave spectral energy density and its maximum were observed. Simultaneously, the maximum of the spectrum moves toward the lower frequencies. During decreasing wind speed, S(f) decreased and the maximum in spectrum moved slightly toward the lower frequencies. At V2, wave spectra evolution during strong Scirocco differs significantly from open sea (Figs. 2c, 2d). The difference is observed for the period of decreasing wind speed and wave energy, when the maximum in spectrum is shifted in time toward the higher frequencies (Fig. 2d). It can be concluded that in enclosed seas of very small fetches (Bracki Channel), the evolution of surface wave spectra in extreme wave conditions is considerably different than in open sea area. The wave spectra evolution for the open Adriatic is very well known [1], while for the channel area it is presented here for the first time. The occurrence of extreme sea states in this channel area is not possible, as confirmed by these results, although this time-series of measurement is not representative. Fetch is the major limiting factor in sea state development in the channel area.

Acknowledgements
This program was financed by the funds of the Croatian Ministry of Environmental Protection, Physical Planning and Construction and by a loan from the IBRD (World Bank).

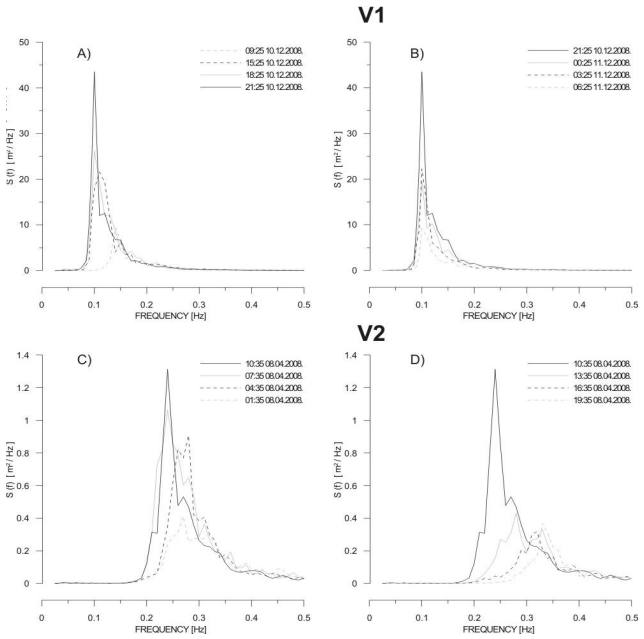


Fig. 2. Evolution of the spectrum for the period of increase of energy up to maximum (A,C) and for the period of decrease of energy (B,D) at station V1 (10.12.2008) and V2 (8.4.2008).

References
1 - Leder N., Smircic A. and Vilibic I., 1998. Extreme values of surface wave heights in the northern Adriatic. *Geofizika*, 15: 1-13.
2 - Smircic A. and Gacic M., 1983. On the saturation range of wave spectra and speed dependence in the North Adriatic. *Rapp. Comm. Int. Mer Medit.*, 28: 2.
3 - Tabain, T., 1997. Standard wind wave spectrum for the Adriatic Sea revisited (1977-1997). *Brodogradnja*, 45: 303-313.

COASTAL DYNAMIC FEATURES ALONG THE NORTHERN LIGURIAN SHELF (PORTOFINO CAPE) IN SUMMER 2004: ROLE OF THE METEOROLOGICAL AND THE TOPOGRAPHIC FORCINGS

M. Locritani [1]*, G. P. Gasparini [2], A. Vetrano [2], P. Povero [3], M. Rixen [4], C. Carmisciano [1] and M. Castellano [3]
[1] Consiglio Nazionale delle Ricerche – ISMAR, La Spezia, Italy
[2] Università degli Studi di Genova, Genova, Italy
[3] NATO Undersea Research Centre, La Spezia,Italy
[4] Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy; Università degli studi di Genova, Genova, Italy - marina.locritani@ingv.it

Abstract
A comprehensive analysis of hydrological, current-meter and meteorological data was performed in the northern Ligurian sea to describe the coastal dynamic near the Portofino cape and its relation with the general cyclonic circulation during summer 2004. Current-meter data was acquired in two coastal sites: the Portofino Cape and the marine area of Arenzano. The hydrological parameters around the cape suggested the presence of two different water masses. The first, located in the lee of the cape, is influenced by local effects, while the second, offshore the cape, is correlated to the general circulation of the Ligurian Sea. The prevalent southern direction of the current in Portofino indicates the presence of a local anticyclonic circulation, associated to the presence of the cape.
Keywords: Currents, Hydrology, Ligurian Sea

A current analysis has been performed in two coastal locations of the Northern Ligurian sea, situated respectively in the eastern and western side of the Gulf of Genova: the Portofino Cape, characterized by a unusual squared-shape of the coast, and the coastal area offshore Arenzano. A very narrow shelf with a very steep slope is typical of the Portofino location, while Arenzano presents a gently sloping bathymetry and a fairly straight coast.

Between July and August 2004, current-meter measures were acquired in the lee side of the cape on a bottom of 30 metres, using a new technology named SEPTR [1] . A hydrological survey was also conducted in the same area in August, using a CTD probe on 36 stations around the cape. In the maritime coastal area of Arenzano an ADCP mooring was placed at 30 m of depth, on a bottom of 50 m. Satellite wind data was acquired by QuikScat for the summer 2004, and compared with the local winds four stations along the Ligurian coast. The aim of this work is to provide a coastal dynamics circulation scheme around the Portofino cape, with particular attention to its interaction with the general cyclonic circulation, and to describe the role of the meteorological and the topographic forcings.

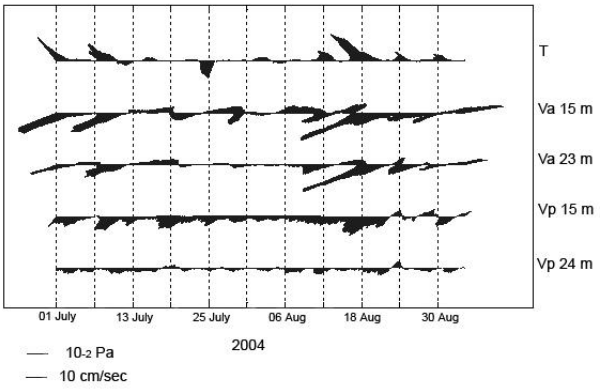


Fig. 1. Five time series are presented: (top) wind stress in Genova (unit 10^{-2} Pa); (second and third) Arenzano currents at 15 m and 23 m respectively; (forth and fifth) Portofino currents at 15 m and 23 m respectively (units: cm/s).

The direct current measures on the lee side of the cape suggest a local re-circulation with a prevalent southern current direction almost perpendicular to the coast. On the other hand the main local current direction in Arenzano is south-west, following the isobaths of the continental shelf [2]. The comparison between Arenzano and Portofino currents shows the maximum correlation of 0.53 for a time lag about 9-10 hours: the Portofino current anticipates the Arenzano one. The ADCP data shows shorter time scale phenomena (few days) in both locations, mainly forced by meteorological events. The study of the baroclinic component of the Portofino currents indicates an important role played by both the wind and the bottom stress. A preliminary meteorological analysis suggests to consider the wind at Genova location, which is prevalently directed towards north-west, with the main intensity-current picks well correlated to all the other wind locations. Comparing the low-frequency current fluctuations of Portofino (15-24 metres deep), of Arenzano (15-23 metres deep) and the Genova wind stress, it is possible to reveal a common time variability between July and August 2004 (Figure 1). The singular topography of the Portofino Cape plays a significant role in the response of the coastal waters to wind forcing and to the general circulation of the Ligurian Sea, determining a small-scale, anti-cyclonic eddy on the western side of the Portofino Cape, according to previous numerical study [3].

References
1 - Tyce R., De Strobel F., Grandi V., Gualdesi L., 1999. Shallow water expendable and trawler safe environmental profilers. *Oceans apos*, 3: 1229 – 1233.
2 - Astraldi M. and Gasparini G.P., 1992. The seasonal characteristics of the circulation in the North Mediterranean basin and their relationship with the atmospheric-climatic conditions. *J. Geophys. Res*., 97: 9531-9540.
3 - Doglioli A., Griffa A., Magaldi M., 2004. Numerical study of a coastal current on a steep slope in presence of a cape: The case of the Promontorio di Portofino. *J. Geophys. Res.*,109: 1-19.

EVOLUTION OF THE WESTERN MEDITERRANEAN THERMOHALINE ANOMALY AS OBSERVED NEARBY BALEARIC ISLANDS (2005-2009)

José Luis López-Jurado [1]*, Cesar Gonzalez-Pola [2] and Pedro Velez-Belchi [3]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Baleares - lopez.jurado@ba.ieo.es
[2] Instituto Español de Oceanografia, Centro Oceanografico de Gijon, Spain
[3] Instituto Español de Oceanografia, Centro Oceanografico de Canarias, Spain.

Abstract

The complex thermohaline structure observed in the Western Mediterranean after the severe winter of 2004-05 is still present in the summer of 2009 at the Balearic Islands. The processes that caused the anomaly are now well identified, as well as the different newly formed water masses. The evolution of the anomaly during the period involves a progressive homogenization of the deep waters masking the layered structure. The final product is a warmer and saltier water type that apparently has incorporated deep waters formed in subsequent winters but not from other intense cascading episodes. On the other hand, Levantine Intermediate waters observed at the north of the Balearic Channels does not present robust trends since mid-90`s.

Keywords: Western Mediterranean, Balear Sea, Deep Waters

The Mediterranean Sea has been immersed in a process of warming and salt-increase at least since the mid 20th century. Anthropogenic global warming and damming of the major rivers have been postulated as the causes of the process. The severe winter of 2004-05 caused the highest heat-loss at the area of deep water formation in the western Mediterranean, triggering the production of immense amounts of cold dense waters that quickly spread along the whole basin creating a complex structure [1]. The new structure was satisfactorily explained as a combination of cascading of very cold and quite fresh waters along the shelf-slope plus the production of saline and warm deep waters at the open ocean.

The trace of the anomaly is clearly visible as a sting-like signature on the TS diagram (Fig 1). Three source waters contribute to it, the coldest mode corresponds to the cascading and the high-saline warm mode of the curve corresponds to the open ocean convection. Both lay below the older deep waters at the end of the straight TS line [2]. The detailed monitoring has shown that the anomaly is extended along the whole basin [3] and persists up to now. The characteristics have evolved towards an homogenization of the layered structure ending with a DW modal water much warmer and saltier than before, with a little contribution of extra cascading waters and intermittent incorporation of open water convection waters, as in winter 2006.

On the other hand, Levantine Intermediate Water properties have been monitored since 1996 at the north of the Balearic Channels. This water mass shows strong interannual variability but not a clear trend during that period, therefore it is not apparently a strong effect caused by the Eastern Mediterranean Transient, at this location.

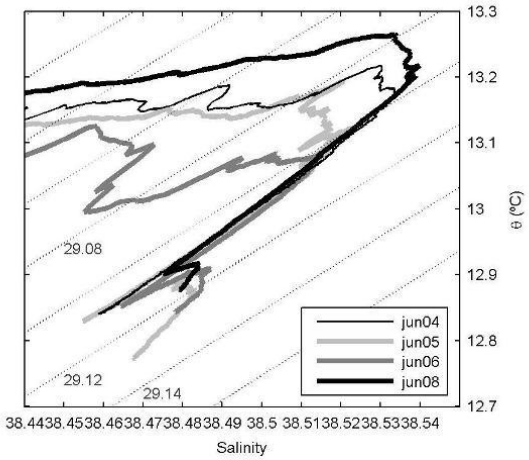


Fig. 1. T/S diagrams at 40 10.00 N and 04 34.96 E (NE Menorca Island).

References

1 - Lopez-Jurado J.L., Gonzalez-Pola C. and Velez-Belchi P., 2005. Observation of an abrupt disruption of the long-term warming trend at the Balearic Sea, Western Mediterranean Sea, in summer 2005. *Geophys. Res. Lett.*, 32, L24606, doi:10.1029/2005GL024430.

2 - Font J., Salat J., Emelianov M., Puig P., Palanques A., Julia A., Lopez-Jurado J.L., Gonzalez-Pola C. and Flos J., 2006. A new Deep Water formed in the NW Mediterranean in 2005. *Geophys. Res. Abstr.* 8, 03081, (SRef-ID: 1607-7962/gra/EGU06-A-03081)

3 - Schroder K., Gasparini G.P., Tangherlini M. and Astraldi M., 2006. Deep and intermediate waters in the Western Mediterranean under the influence of the Eastern Mediterranean Transient. *Geophys. Res. Lett.*, 33, L21607, doi:10.1029/2006GL02712.

NORTH ADRIATIC WINDS AND THE RESIDUAL CURRENTS IN THE INLETS OF THE VENICE LAGOON

Isaac Mancero-Mosquera [1]*, Miroslav Gacic [1] and Andrea Mazzoldi [2]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale. Trieste, Italy. - imancero@ogs.trieste.it
[2] Istituto di Scienze Marine - CNR. Venice, Italy.

Abstract
The principal components of the wind measured in front of the Venice lagoon are related to the variability of the residual flow in the inlets connecting the lagoon with the Adriatic sea. Lido and Chioggia inlets have an exponential response to the Principal component of the wind (PC1); while the second component (PC2) affects only the Chioggia inlet in a linear way. Thus, during Bora events (detected mainly in PC1 series), the inflow through Lido channel is reinforced as well as the outflowing in Chioggia. On the other hand, Sirocco events (detected in the PC2 series) slow down the outflowing in Chioggia.

Keywords: Adriatic Sea, Currents, Time Series, Wind/Font

Introduction.
Current velocities are monitored in the three inlets, i.e., Lido, Malamocco and Chioggia, connecting the Venice lagoon with the Adriatic Sea. They are relatively narrow and shallow thus making the flow highly polarized along the channel axis, and barotropic. Therefore, analyses carried out on the vertical averages of along-channel components (obtained via Principal Component analysis) can be considered fairly accurate. It is well documented [1] that the astronomic tides account for most of the energy of the current flow, so that more than 90% of the energy can be removed via Harmonic Analysis. Still, an important portion of energy coming from the open sea and atmospheric forcing is evident in the non-tidal component. A quantification of the wind effect on the current velocities is attempted by removing the energy of seiche oscillations and decomposing the wind into its principal components.

Adriatic Seiches and Wind Decomposition
A translation-invariant Wavelet transform was applied to the de-tided vertically-averaged current series in order to decompose the variance on a scale-by-scale basis. It was found that the main portion of energy was in the scales containing the main Adriatic seiche modes of 11 and 22 hours. An additional free oscillation with periodicity of 4.87 hours was also detected. Seiche signals were removed by fitting the corresponding wavelet scales to the de-tided time series. The 88% of non tidal variability in Lido, 92% in Malamocco and 85% in Chioggia were thus removed, leaving the residual time series ready for comparison with the wind vector time series.

Winds were decomposed by Principal Component Analysis. The main axis of variance (PC1) is aligned with the strongest wind in the area, i.e., Bora; while the second component (PC2) is aligned mostly with the Sirocco direction of blowing. Since the principal components are independent up to 2nd order statistics [2], correlations were computed separately between the wind components and the residual currents time series.

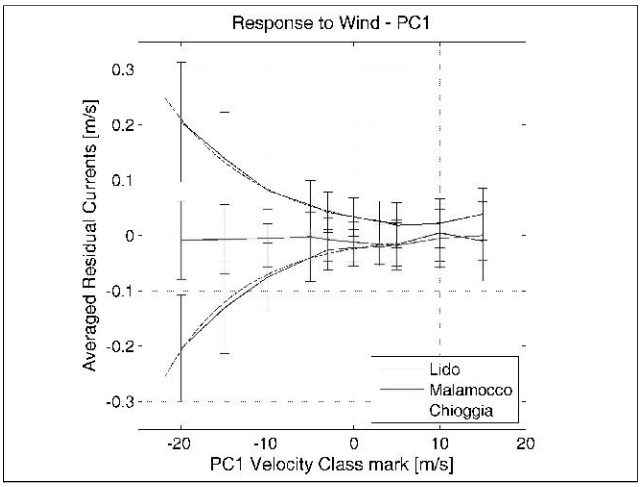


Fig. 1. Exponential response of residual currents in Lido (lower side) and Chioggia (upper side) to PC1 wind velocity classes. Dashed lines show the model fitted to the data. The negative region in PC1 is where actual Bora events are detected. Positive currents mean outflowing from the lagoon.

Results
Overall linear correlation between residual currents is low, on the order of 0,4 in magnitude; but they increase until 0,7 in absolute values during specific events of Bora and Sirocco blowing. The connection is specifically stronger between PC1 and Lido as well as PC1 and Chioggia, but in opposite sense: a Bora event would lead to a stronger inflow of water through the northern Lido channel but reinforcing the out flowing through Chioggia channel in the southern part of the lagoon, with Malamocco showing no significant response at all. Chioggia inlet flow shows also a response to PC2 winds, especially during Sirocco event which slows down the residual out flowing in the inlet. A partition of wind components were done, defining a calm state between -3m/s and 3m/s. Other partition limits being +/-5m/s, +/-10m/s, +/-15m/s and +/-20 m/s. Thus, the effect of PC1 is studied while forcing a calm state on PC2; conversely, PC1 is conditioned to the calm state to study the PC2 effects. It has been found that the flow of Lido and Chioggia inlets has an exponential response to the PC1 wind velocity classes with exponential rates of b = -0,1 following the model Y = A.exp(b.PC1) where A is -0,021 for Lido and 0,033 for Chioggia (Fig. 1). Likewise, the response of Chioggia to PC2 wind velocity classes has a linear fashion Y = a.PC2 + b with a = -0,0036 and b = 0,03844 (Fig. 2). The explained variance is over 96% in each case.

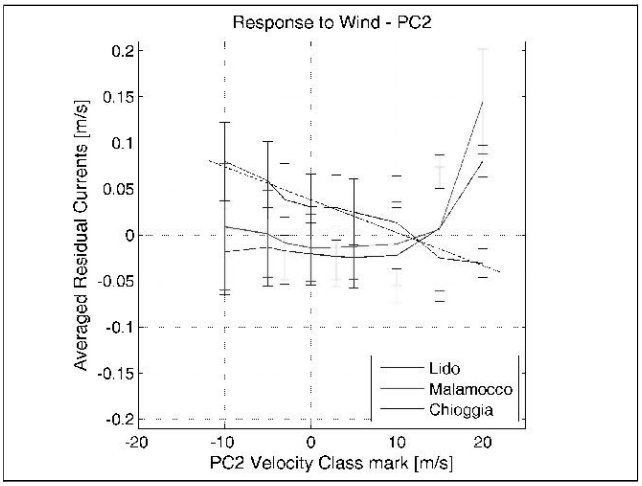


Fig. 2. Linear response of Chioggia residual flow to PC2 wind velocity classes. Dashed line shows the model fitted to data. Lido and Malamocco show no response until PC2 reaches a 15m/s or higher velocity, when the residual flow in Chioggia inlet change its sign. The positive region in PC2 is where actual Sirocco events are detected.

References
1 - Gacic M., Mancero Mosquera I., Kovacevic V., Mazzoldi A., Cardin V., Arena F. and Gelsi G., 2004. Temporal variations of water flow between the Venetian lagoon and the open sea. *J. Marine Syst.*, 51: 33-48.
2 - Preisendorfer R.W., 1988. Principal component analysis in meteorology and oceanography. Elsevier Science Ltd., Amsterdam.

STORM SURGE VARIATIONS IN THE MEDITERRANEAN SEA UNDER CLIMATE CHANGE SCENARIOS

M. Marcos [1], G. Jordà [1], D. Gomis [1]*, F. M. Calafat [1] and E. Alvarez - Fanjul [2]
[1] IMEDEA (CSIC-UIB), Esporles, Spain - damia.gomis@uib.es
[2] Puertos del Estado, Madrid, Spain

Abstract

A 2D ocean numerical model covering the Mediterranean Sea and the NE Atlantic sector has been forced by atmospheric pressure and wind fields generated by dynamical downscaling over the European region that follow three climate change scenarios (A2, A1B and B1). The variability of the obtained atmospherically-induced sea level has been compared among scenarios and with a re-analysis of the period 1960-2000 carried out with the same numerical model. The analysis presented here focuses on the changes in the decadal variability of mean sea level and in sea level extremes projected for the 21st century

Keywords: Air-Sea Interactions, Sea Level

Sea level is an important parameter for coastal habitats and infrastructures and has been recognized as a key indicator of global climate change. During the last years there has been a growing interest among the scientific community in understanding sea level changes, given the impact that sea level rise may have in coastal and highly populated areas. Global sea level rise during the 20th century has been estimated in 1.8 mm/yr [1], while in the Mediterranean coastal sea level derived from the longest tide gauges indicates a rate of sea level rise of 1.1–1.3 mm/yr [2]. In a world with a higher mean sea level, high waters caused by storm surges will have increasing hazardous impacts on coastal areas. However, while projections of climate models mostly agree and predict a continuous increase in mean sea level in many parts of the globe during the 21st century, no consensus has been reached in respect to the changes in storminess [1]. This work aims at obtaining regional projections of storm surges in the Mediterranean Sea and the adjacent NE Atlantic area for the 21st century under different climate change scenarios on the basis of regional atmospheric and oceanic numerical models. Extreme sea level events are commonly driven by the combination of tidal elevation and storm surges. However, the non-linear interaction between tides and surges in the Mediterranean is negligible and can thus be ignored [3] Therefore we will concern ourselves only with the storm surges component. High frequency (6h) atmospheric pressure and wind fields are obtained as the output of a global atmospheric model with variable-resolution (50 km over the Mediterranean [4]). The atmospheric model is run for the period 2000-2100 forced by greenhouse gases (GHG) and aerosols concentrations following the A2, A1B and B1 SRES scenarios. Two more runs have been carried out for the period 1960-2000. One was forced by observed GHG and aerosols concentrations (the control run). The second is a dynamical downscaling of ERA-40 re-analysis fields. The atmospheric fields are used to force the oceanic barotropic model HAMSOM over the area 30ºN to 47ºN and 12ºW to 35ºE, which covers the Mediterranean Sea and the NE Atlantic adjacent sector with a spatial resolution of 1/4ºx1/6º. Mean values and decadal variability of atmospherically-induced sea level will be examined and compared between the different runs for the 21st century and with the results obtained for the 20th century. The hourly outputs will be used to explore the changes in the magnitude and frequency of extreme sea level events under climate change scenarios.

References

1 - IPCC, 2007. Climate change: the physical science basis. *In:* Contribution of the Working Group I to the Fourth Assessment report of the Intergovernmental Panel on Climate Change, 996 pp., eds Solomon, S., Qin, D.,Manning, M., Chen, Z.,Marquis, M., Averyt, K.B., Tignor,M. and Miller, H.L., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

2 - Tsimplis M.N and Baker T.F., 2000. Sea level drop in theMediterranean Sea: an indicator of deep water salinity and temperature changes?, *Geophys. Res. Lett.*, 27(12): 1731–1734.

3 - Marcos M., Tsimplis M.N. and Shaw A.G.P., 2009. Sea level extremes in southern Europe, *J. Geophys. Res*., 114, C01007, doi:10.1029/2008JC004912.

4 - Herrmann M.J., and Somot S.,2008. Relevance of ERA40 dynamical downscaling for modeling deep convection in the Mediterranean Sea, *Geophys. Res. Lett*., 35, L04607, doi:10.1029/2007GL032442

THE SST MULTI-DECADAL VARIABILITY IN THE ATLANTIC-MEDITERRANEAN REGION

Salvatore Marullo [1]*, Vincenzo Artale [1] and Rosalia Santoleri [2]
[1] ENEA - CR Frascati (Italy) - salvatore.marullo@enea.it
[2] CNR-ISAC, Roma (Italy)

Abstract

The multi-decadal variability of the Mediterranean Sea Surface Temperature (SST) field is analyzed using different datasets. The analysis of the Mediterranean SST revealed the presence of an evident oscillation of about 70 years. The same oscillation was found only in the North Atlantic Ocean and corresponds to Atlantic Multidecadal Oscillation (AMO). Singular Spectral Analysis and MTM applied to Mediterranean and Atlantic quantitatively confirmed the importance of this oscillation. The analysis of the correlation between SST and NAOI (North Atlantic Oscillation Index) suggests the importance of the external atmospheric forcing for most of the last 150 years.

Keywords: Temperature, Surface Waters, Open Sea, Global Change

Data and Methods

In this work we used the Extended Reconstructed SST (ERSST.v3) dataset (1854-present, monthly, 2 deg spatial resolution) [1] and the Hadley Centre Sea Ice and Sea Surface Temperature (HadISST) dataset (1870-present, monthly, 1 deg spatial resolution) [2] and we analyzed the consistency between the two datasets. At global level, when yearly averages are considered, seasonal or spatial discrepancies between ERSST.v3 and HadISST tend to compensate and the two datasets exhibit similar behaviors. The relatively high abundance of data in the Mediterranean Sea, allow us to produce a new estimate (MArtaS) of the mean monthly sea surface temperature of the Mediterranean Sea using only ICOADS (International Comprehensive Ocean-Atmosphere Data Set) SSTs. MArtaS (Marullo-ARTAle-Santoleri) is based on a simple space average of the available monthly data introducing a correction factor F that takes into account the presence of data voids for each specific month of the year. In spite of its crudeness MArtaS, that is not based on interpolated data, follow quite closely the other two series with differences that rarely exceed 0.1°C. The agreement between the two interpolated SST series (ERSST.v3, HadISST) and the non interpolated one (MArtaS) suggests that dumping or other possible distortions due to the interpolation are not dominant in the Mediterranean basin when yearly averages are used. On the contrary, when monthly means are used, the difference between two interpolated data sets became larger exhibiting a marked annual cycle with an amplitude of about 0.8 °C.

Spectral Analysis, Correlations and NAOI

In order to obtain the signal to noise separation we computed the eigenvalues spectrum of the SST time series using Singular Spectral Analysis (SSA). The first two leading EOFs, that explain about 40% of the total variance and capture the low frequency variability of the SST, have approximately the same amplitude (considering the range of error bars) and are in quadrature. This fact could be interpreted as the occurrence of a ghost limit cycle related to a physical oscillation of the dynamical system that has generated the SST time series [3]. The low frequency variability of the Mediterranean was also investigated applying the Multi Taper Method (MTM) to the de-trended yearly SST. The Multitaper method is a technique developed by D.J. Thomson [4] to estimate the power spectrum of a stationary ergodic finite-variance random process. This method provides useful tools for the spectral estimation of a relatively short time series whose spectrum may contain both broadband and line components. The F-test criterion for harmonic signals yields 6 peaks at the 99% confidence level and 10 peaks at the 95% confidence level that can eventually be associated to some harmonic, phase-coherent oscillation. Peaks at 73, 6.3, and 2.8 years exceed the 99% confidence level in the harmonic test and correspond to significant spectral bands in the power spectrum. The higher frequency peaks are very close to the preferred scale of variability of the ENSO's quasi-biennial and low-frequency modes while the lower frequency one is very similar to the AMO (Atlantic Multidecadal Oscillation). Similar peaks are also observed in the North Atlantic ocean. The evidence that both North Atlantic ocean and Mediterranean Sea exhibit the same multi-decadal climate cycle suggests the occurrence of a common external forcing, likely of atmospheric origin, probably coupled with some internal oscillation[5]. Correlation analysis between NAOI [6] and SST in the Mediterranean and Atlantic Ocean reveals that NAOI is significantly (90%) negatively correlated with SST only in the Eastern Mediterranean Sea (only during Winter), and in the two centers of the NAOI (during the four seasons): The tropical Atlantic and the sub-polar gyre area.

References

1 - Smith T.M., Reynolds R.W., Peterson T.C. and Lawrimore J., 2008. Improvements to NOAA's Historical Merged Land-Ocean Surface Temperature Analysis (1880-2006). *J. Climate*, 21: 2283-2296.

2 - Rayner N. A., Parker D. E., Horton E. B., Folland C. K., Alexander L. V., Rowell D. P., Kent E. C., Kaplan A., 2003. Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century. *J. Geophys. Res*., 108, D14, 4407 10.1029/2002JD002670.

3 - Ghil M., Allen M.R., Dettinger M.D., Ide K., Kondrashov D., Mann M.E., Robertson A.W., Saunders A., Tian Y., Varadi F. and Yiou P., 2002. Advanced spectral methods for climatic time series. *Rev. Geophys*., 40 (1): 1-41.

4 - Thomson D. J., 1982. Spectrum estimation and harmonic analysis. *Proc. IEEE*, 70: 1055–1096.

5 - Calmanti S., Artale V. and Sutera A., 2006. North Atlantic MOC variability and the Mediterranean outflow: a box-model study. *Tellus A* , 58A: 416-423.

6 - Li J. and JWang J.X.L., 2003. A New North Atlantic Oscillation Index and Its Variability. *Adv. Atmos. Sci.*, 20 (5): 661-676.

HIGH RESOLUTION GLIDER MEASUREMENTS AROUND THE VERCELLI SEAMOUNT (TYRRHENIAN SEA) IN MAY 2009

E. Mauri [1]*, G. Bolzon [1], A. Bubbi [1], F. Brunetti [1], R. Gerin [1], N. Medeot [1], R. Nair [1], S. Salon [1] and P. Poulain [1]
[1] Istituto Nazionale di Oceanografia e Geofisica Sperimentale (OGS), Trieste, Italy - emauri@inogs.it

Abstract
Physical and bio-chemical characteristics of the upper water column in the vicinity of the Vercelli Seamount were studied from the 23rd to the 30th of May 2009 using a Slocum shallow battery-powered glider. In addition to mesoscale and sub-mesoscale structures crossed by the glider, the near-surface water properties changed abruptly on the 27th of May under the influence of a cold near-surface plume originating from the Strait of Bonifacio and triggered by Mistral winds.
Keywords: Tyrrhenian Se, Surface Waters

Introduction
The "Tyrrhenian Seamounts Ecosystems: an Integrated Study" (TySEc) experiment took place in the Tyrrhenian Sea in late Spring 2009 with the aim of studying the geomorphologic characteristics and the hydrodynamics of the area over and around a seamount. Seamounts are sites of high productivity with coexisting biocenosis in a relative limited space, moreover they represent 'stopping stations' in the benthonic dispersion processes. Their importance on the ecology of the marine environment and of their high level of vulnerability to the global climate change represents an interesting subject in different international projects.

As part of the TySEc experiment, the "Trieste-1" glider was operated in an area of roughly 750 km^2 over the Vercelli Seamount (Figure 1) for a period of about 8 days (from the 23rd to the 31st of May). The seamount is located in the northern Tyrrhenian Sea, (41°05' N / 10°53' E), and its summit reaches 55 m below the sea surface. The glider was configured to provide oceanographic data during the ascending phase of the saw-tooth path, every 0.75 km. During the entire campaign 300 profiles between 4 and 180 m depth were acquired, providing temperature, salinity, oxygen, fluorescence, and turbidity data.

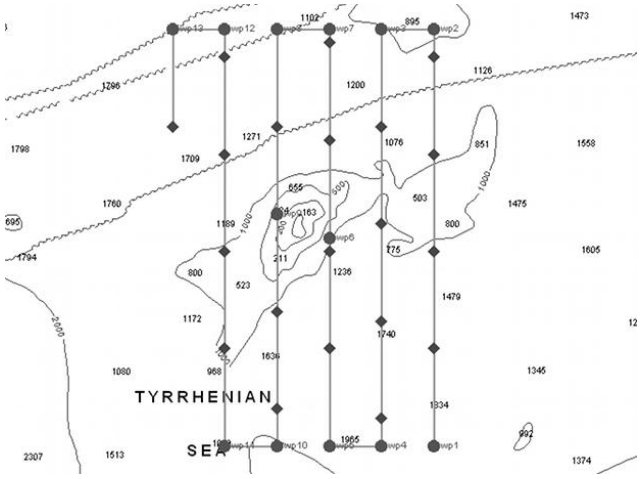


Fig. 1. Details of the glider track overlaid on the bathymetry showing the Vercelli Sea mount.

Results
A shallow (5-10 m deep) mixed-layer with maximum temperature of 23°C was present until the 27th of May, when the temperature at the surface abruptly decreased to 21°C and the mixed layer deepened to over 15 m (Figure 2). Satellite sea surface temperature images and sea level anomaly maps reveal that this change corresponds to the expansion/intrusion of a relatively cold near-surface plume originating from the Strait of Bonifacio (between Corsica and Sardinia). Due to sustained Mistral winds, there is an increase of the double gyre structure associated with the plume. In particular, the southern anticyclonic gyre strengthen on the 27th of May, advecting cold water which reaches the study area.

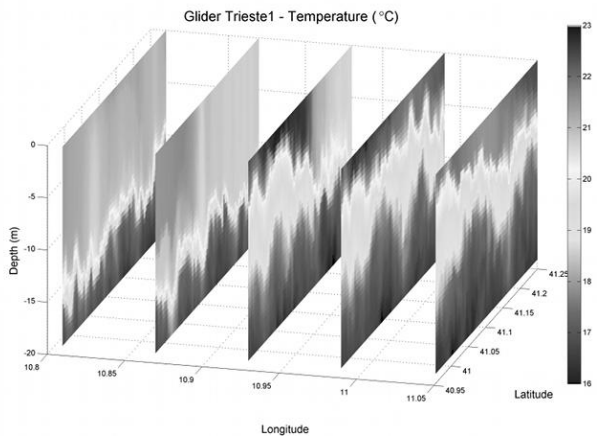


Fig. 2. Contour plot of the temperature (°C) along the glider track between 4 and 20 m.

The salinity which was essentially minimal (around 37.7) near the surface before the 27th of May, increases to 38.0-38.1 in the surface mixed layer, while a layer with minimum salinity develops near the base of the mixed layer (10-20 m). Contemporarily the dissolved oxygen maximum deepens from the surface to the base of the mixed layer (10-20 m). In addition to the above evolution of the water mass properties, high frequency (with periods of 0.5 day or less) variations are ubiquitous and are mostly apparent near the base of the mixed layer. They correspond to mesoscale and sub-mesoscale structures crossed by the glider and to tidal/internal waves. Below the mixed layer, the salinity and oxygen distributions show correlated structures (high salinity corresponding to low oxygen) all the way down to 180 m. A sub-surface maximum in chlorophyll concentration and turbidity is also seen between 60 and 80 m. Apparently the Vercelli Seamount has little effect on the water properties measured by the glider.

The "Trieste-1" glider is involved in the DORII project (Development of Remote Instrumentation Infrastructure) whose objective is the integration of observations and model simulations in the Grid. DORII e-Infrastructure is based on the concept of instrument element, that virtualized an instrument within the Grid. More generally, a computational Grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities [1].

References
1 - Foster I. and Kesselman C., 1998. The Grid: Blueprint for a New Computing Infrastructure, Edited by Ian Foster and Carl Kesselman, Morgan Kaufmann Publishers,1998, San Francisco,CA, 675 pp.

MULTI-SENSOR SATELLITE TIME SERIES OF OPTICAL PROPERTIES AND CHLOROPHYLL A CONCENTRATION IN THE ADRIATIC SEA

F. Mélin [1]*, J. Berthon [1], M. Clerici [1], D. D'alimonte [2], V. Vantrepotte [1] and G. Zibordi [1]
[1] E.C. Joint Research Centre, Institute for Environment and Sustainability, Ispra, Italy - frederic.melin@jrc.ec.europa.eu
[2] Centro de Inteligencia Artificial, Univ. Nova de Lisboa, 2829-516, Caprica, Portugal

Abstract
Advanced remote sensing techniques and algorithms are combined to produce and analyse an improved 12-year multi-sensor time series of bio-optical properties for the Adriatic Sea. First, a multi-sensor series of normalized water-leaving radiance is created with an optically-based merging technique applied to SeaWiFS and MODIS data. Then, two empirical algorithms, embedded in a dynamic algorithm selection scheme, serve to compute the concentration of chlorophyll a (Chla), and distributions of inherent optical properties are obtained with a semi-analytical bio-optical model.
Keywords: Adriatic Sea, Ocean Colours, Remote Sensing, Chlorophyll-a

Introduction
The potential of satellite ocean colour for monitoring and studying marine ecosystems could be better exploited in coastal and marginal seas if the uncertainties associated with satellite products could be reduced. Moreover, the creation of a long-term satellite data record needs to address the combination of satellite products derived from different space missions. This work aims at generating and presenting a time series of improved quality-assessed bio-optical products for the Adriatic Sea using advanced remote sensing techniques and specific algorithms.

Satellite Data Merging
Building on previous work [1, 2], an optically-based technique is proposed to merge L_{WN} from SeaWiFS and MODIS by averaging sensor-specific values after wavelength differences are corrected by a band-shift correction scheme. The resulting 12-year series of L_{WN} serves to generate derived products of optically signifiant constituents. Field measurements collected at the Acqua Alta Oceanographic Tower (AAOT) located in the North Adriatic [3] provide a unique data set for validation of the merged L_{WN}. Uncertainty estimates decrease from 28% at 412 nm to 10% between 490 and 555 nm.

Development of Derived Products
A single empirical algorithm for calculating Chla is unlikely to produce a data set with a consistent level of uncertainty across the optical diversity of the Adriatic basin. The approach adopted here, based on the novelty detection technique [4], is to distinguish two dominant water types, representing offshore waters (Class 1) and coastal regions (Class 2), and dynamically blend the outputs from the associated algorithms [5, 6] according to the probability of the input L_{WN} of belonging to a specific optical class. The optical classes are defined by bio-optical datasets made of globally-distributed measurements representative of offshore clear waters and the data collected at AAOT. The Chla dataset is completed by inherent optical properties obtained with a semi-analytical algorithm [7]. Uncertainties for these optically significant constituents are estimated with field data collected at the AAOT site. For instance, the RMS difference computed for log-transformed Chla amounts to 0.15.

Applications
A 12-year budget shows that 66% and 8% of the basin are classified as Class 1 and 2, respectively. Most of the points that are left un-classified have optical properties located along the gradient (in optical space) between Classes 1 and 2. The areas classified as Class 2 are mostly located in the northwest Adriatic and along the Italian coast. Average values for north, central, and south Adriatic are, respectively, 0.58, 0.21 and 0.18 mg m^{-3} for Chla, 0.023, 0.013 and 0.012 m^{-1} for phytoplankton absorption at 443 nm, 0.074, 0.040 and 0.035 m^{-1} for absorption due to chromophoric dissolved organic matter and non-pigmented particles at 443 nm, and 0.0054, 0.0029 and 0.0026 m^{-1} for particle backscattering at 555 nm. Finally, the temporal variability of the time series is analysed with statistical techniques distinguishing seasonal and trend components [8]. A significant amount of interannual variations are found, particularly in the North and Central Adriatic, with Chla values that tend to be higher at the beginning of the data record.

Conclusion
The Adriatic basin displays a significant diversity in optical water types, and has thus served as a testbed for new approaches. Combining these led to the definition of a multi-sensor 12-year record for optically significant constituents, particularly a much-improved time series of Chla. The applicability of this framework to other European seas depends on several factors, including the optical properties associated with the considered region, and the in situ data available to statistically model these properties, and the uncertainties associated with the primary ocean colour product that is L_{WN}.

References
1 - Mélin, F., and Zibordi, G., 2007. An optically-based technique for producing merged spectra of water leaving radiances from ocean color. *Appl. Opt.*, 46: 3856-3869.
2 - Mélin F., Zibordi G. and Djavidnia S., 2009. Merged series of normalized water leaving radiances obtained from multiple satellite missions for the Mediterranean Sea. *Adv. Space Res.*, 43: 423-437.
3 - Zibordi, G., et al., 2009. AERONET-OC: A network for the validation of ocean color primary radiometric products. *J. Atmos. Ocean. Tech.*, 26: 1634-1651.
4 - D'Alimonte, D., Mélin, F., Zibordi, G. and Berthon, J.-F., 2003. Use of the novelty detection technique to identify the range of applicability of the empirical ocean color algorithms. *IEEE Trans. Geosci. Remote Sens.*, 41: 2833-2843.
5 - D'Alimonte, D., and Zibordi, G., 2007. Phytoplankton determination in an optically complex coastal region using a multilayer perceptron neural network. *IEEE Trans. Geosci. Remote Sens.*, 41: 2861-2868.
6 - Volpe, G., Santoleri, R., Vellucci, V., Ribera d'Acalà, M., Marullo, S. and D'Ortenzio, F., 2007. The colour of the Mediterranean Sea: Global versus regional bio-optical algorithms evaluation and implication for satellite chlorophyll estimates. *Remote Sens. Env.*, 107: 625-638.
7 - Lee, Z.P., Carder, K.L. and Arnone, R.A., 2002. Deriving inherent optical properties from water color: a multiband quasi-analytical algorithm for optically deep waters. *Appl. Opt.*, 41: 5755-5772.
8 - Vantrepotte, V., and Mélin, F., 2009. Temporal variability of 10-year global SeaWiFS time series of phytoplankton chlorophyll *a* concentration. *ICES J. Mar. Sci.*, 66: 1547-1556.

SUBSURFACE (350 M) CIRCULATION IN THE MEDITERRANEAN SEA BASED ON ARGO DATA

Milena Menna [1]* and Pierre Marie Poulain [1]

[1] Istituto nazionale di Oceanografia e di Geofisica Sperimentale- OGS, Sgonico (TS), italy - mmenna@ogs.trieste.it

Abstract

The trajectories of 38 Argo floats, deployed in the Mediterranean Sea between October 2003 and September 2009, are used to create a dataset of velocities at 350 m and to study the subsurface circulation in regions with good data coverage. The float subsurface velocities and the pseudo-Eulerian statistics computed from them show typical circulation pathways, which can be related to the motion of the Levantine Intermediate Water.

Keywords: Intermediate Waters, Currents, Eastern Mediterranean, Western Mediterranean

Among all the floats deployed in the Mediterranean Sea, we have selected 38 instruments according to their cycle characteristics. They were deployed as part of the MFSTEP project in 2003 and are referred to as MedArgo floats. Each float descents from the surface to a programmed parking depth of 350 m, where it remains for about 4 days before reaching the profile depth, that is generally 700 m but extends to 2000 m every ten cycles. At the end of each cycle the float remains for about 6 hours at the sea surface, where it is localised by, and transmit the data to, the Argos satellite system [1].

The Argos positions were used to determine the subsurface currents through three different steps: the first provides rough estimates of subsurface velocities (V_{old}) [2]; the second produces the best surface displacement [3]; the third provides the subsurface displacement (V_{350}) that involves the use of the average vertical speed of the float and an approximation of current shear in the upper water column [4]. From the comparison between V_{old} and V_{350} and the results of the statistical analysis computed on V_{350}, we select only the best estimates of velocities (variance explained/total variance > 0.8) to produce the final dataset V_{350}^{end} (Fig.1) [4].

The V_{350}^{end} velocities reach the maximum values of ~ 33 cm/s east of the Balearic Islands and in the Ierapetra Eddy; high speeds (larger then 20 cm/s) are also found in the north and central regions of the Liguro-Provençal-Catalan basin and in some eddies of the Eastern basin, whereas the Liguro-Provençal, Algerian and Libyan-Egyptian Currents are characterised by maximum speeds of 15 cm/s.

The pseudo-Eulerian statistics, computed with V_{350}^{end}, show typical circulation pathways related to Mediterranean subsurface currents and to the motion of the Levantine Intermediate Water. In the Western Mediterranean basin, the velocity field reveals the characteristic cyclonic paths in the Tyrrhenian, Liguro-Provençal and Algerian sub-basins, as well as the Algerian and Liguro-Provençal-Catalan currents, where it reaches the maximum intensities (12-14 cm/s). In the southern Ionian Sea, the float velocities show a dominant anticyclonic circulation between 32°-36° N and 16°-20.5° E, in which the southern limb corresponds to a north-westward flow located on the African continental slope. The rest of Eastern Basin is dominated by mesoscale and sub-basin scale circulation eddies, with maximum values of mean velocity (~ 12 cm/s) located south of Crete (Ierapetra eddy) and south of Cyprus. All over the Mediterranean Sea the EKE has strong gradients compared to MKE.

In the regions with significant bathymetry gradients, that is mostly along the continental shelf slope, subsurface currents are driven by topography and the along-isobath components of velocity have values larger then the across-isobath components. Speeds have mean values of ~5 cm/s and reach 20-27 cm/s east of the Balearic Islands, in the Cretan Passage and in the southern entrance of Tyrrhenian Sea.

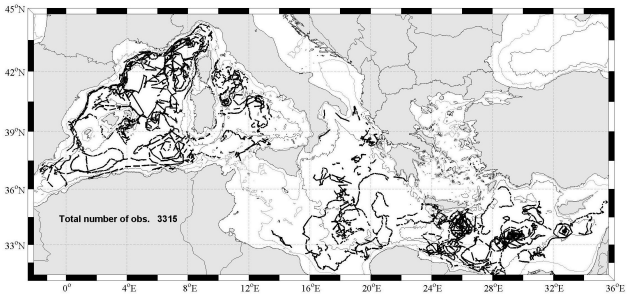


Fig. 1. Subsurface raw trajectories of the MedArgo floats between October 2003 and September 2009.

References

1 - Poulain P.-M., Barbanti R., Font J., Cruzado A., Millot C., Gertman I., Griffa A., Molcard A., Rupolo V., Le Bras S., and Petit de la Villeon L. , 2006. MedArgo: a drifting profiler program in the Mediterranean Sea, *Ocean Sci*., 3: 1901-1943.

2 - Lebedev K.V., Yoshinari H., Maximenko N.A., and Hacker P.W., 2007. Velocity data assessed from trajectories of Argo floats at parking level and at the sea surface, *IPRC Technical Note*, 4 (2).

3 - Park J.J., Kim K., King B.A. and Riser S.C. , 2005. An advanced method to estimate deep currents from profiling floats, *J. Atmos. Ocean. Tech*., 22 (8): 1294-1304.

4 - Menna M., and Poulain P.-M. ,2009. Valutazione delle correnti sub-superficiali nel Mediterraneo da float Argo, *Technical Report* 2009/95-OGA-15-SIRE, pp. 1-63, Trieste.

ON THE EXTERNAL SEA LEVEL FORCING OF METEOTSUNAMIS AT THE BALEARIC ISLANDS

Sebastian Monserrat [1]* and Marta Marcos [2]
[1] Universitat de les Illes Balears, Mallorca, Spain - s.monserrat@uib.es
[2] Institut Mediterrani d'Estudis Avançats IMEDEA (UIB-CSIC), Mallorca, Spain

Abstract
High frequency sea level observations at four coastal sites are used to examine the external forcing causing significant seiches (meteotsunamis) in certain harbours at the Balearic Islands. Forcing characteristics estimated for different events are different, while for the same events are similar, even for sites located far away from each other. Spectacular similarities are found for two specific sites, Ciutadella (Menorca Island) and Cala Ratjada (Mallorca Island).
Keywords: Mesoscale Phenomena, Coastal Engineering

High frequency sea level oscillations in bays and harbours, known as seiches, may reach significant amplitudes depending on the external forcing in the open sea and the local topographic response. When resonance occurs, the phenomenon may pose important risks to the infrastructures as well as to the commercial or fishing activities and sometimes even threatening to human lives. When the external forcing responsible of such amplification consists of long waves generated by an atmospheric origin they are referred to as meteotsunamis. Meteotsunamis are similar to ordinary tsunami waves and can produce similar damages at the coast, although the catastrophic effects related to this type of waves are normally observed only in specific bays and inlets. One of the places where meteotsunamis with the largest sea level amplitudes are reported is Ciutadella Harbour, a natural elongated and shallow inlet located in the western coast of Menorca Island (NW Mediterranean, see Figure 1).

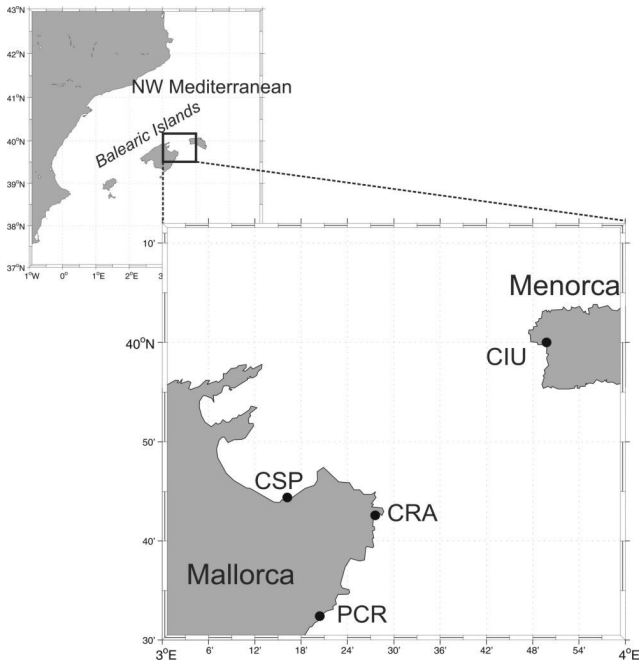


Fig. 1. Map of the area and location of the stations.

The phenomenon is locally known as "rissaga" and occurs every year mostly in late spring and summer. Ciutadella seiche has a period of approximately 10.5 minutes and typical background amplitude of few centimetres. Typical rissaga events have amplitude of around 1 m, but they may reach up to 4-5 m through to crest in an average water depth of 5 m in singular episodes. In this paper we analyze a recent set of sea level measurements recorded around de Balearic Islands (Mallorca and Menorca) to characterize large amplitude seiche oscillations at four tide gauge locations (Figure 1). The effects of the local topography and bathymetry are isolated at each site by computing the background spectral content of the sea level oscillations in absence of forcing, that is, for time periods with very small amplitudes inside the inlets. Background spectra strongly vary from one site to another but are approximately independent of time. Then, the average of several background episodes may be considered as a good proxy for the local resonant response of the given site. The frequency response of the forcing for each episode has been computed as the spectral ratio of the energy content of a seiche event and the background spectra [1]. The more constant is the background spectra for a tide gauge site, the more liable and accurate is the characterization of the external forcing. For all the episodes, the energy content for the external forcing is concentrated in periods between 5 and 50 min at the four sites. Different forcings are found among sites and events, the latter due not only to the amplitude of the incoming waves but also to the inlet orientation and other parameters. It is found that external sea level forcing at CIU and CRA are very similar, although the responses of both inlets differ significantly. The forcing is almost the same for signals with frequencies lower than 30 min^{-1}. For higher frequencies, changes in the travelling atmospheric pressure from Mallorca to Menorca seem to play a major role in the generated sea level oscillations and the obtained sea level forcing is somewhat less coherent, although the magnitude of the energy content is always comparable between the two sites.

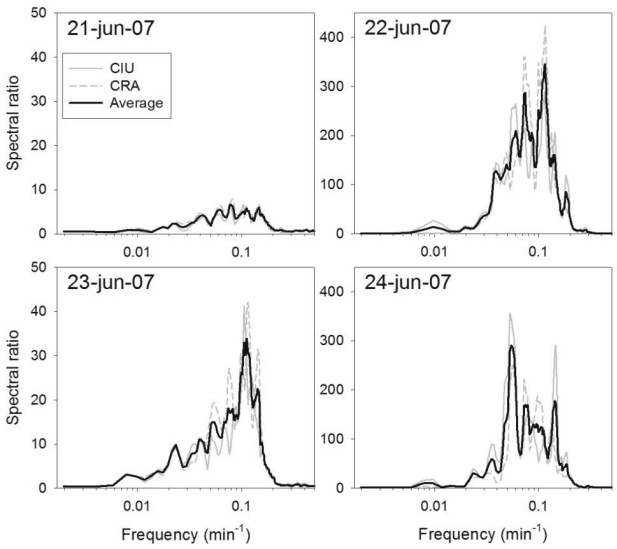


Fig. 2. One example of the spectral ratios ("source functions") of daily spectra for the rissaga event of 21-24 June 2007. Black line is the average of the spectral ratio at CIU and CRA.

Therefore, sea level oscillations in CRA could be used as an indication of an incoming rissaga event in CIU and should be used as part of an eventual rissaga warning system designed to mitigate the possible damages inside CIU harbour, maybe as part of the Mediterranean Tsunami Warning System ICG/NEAMTWS.

References
1 - Monserrat S., Rabinovich A. and Casas B., 1998. On the reconstruction of the transfer function for atmospherically-generated seiches. *Geophys. Res. Lett.*, 251 (12): 2197-2200

SPECTRAL SIGNATURES OF PIGMENTS IN THE KAŠTELA BAY

M. Morovic [1]*, M. Kiševic [2], A. Smailbegovic [3], V. Flander Putrle [4], R. Andricevic [2] and B. Grbec [1]
[1] Institute of Oceanography and Fisheries, Split, Croatia - morovic@izor.hr
[2] Faculty of civil engineering and architecture, Split, Croatia
[3] Charleston College, Charleston, USA
[4] Marine Biology Institute, Piran, Slovenia

Abstract
Several cruises were performed in the middle Adriatic coastal area (Kaštela Bay) in late spring and early fall 2009 with an hyperspectral sensor and an in-situ optical profiler, accompanied with other oceanographic measurements and measurements of in-situ pigments. Spectral surface signatures revealed a difference between the two optical methods.
Keywords: Adriatic Sea, Ocean Colours, Pigments

Two kinds of optical measurements were performed at 8 stations in the Croatian Adriatic coast (Figure 1) during three cruises in May and October 2009. Multispectral in-situ irradiances and radiances were measured with a Biospherical optical profiler PRR800 at 14 wavebands (340; 380; 412; 443; 465; 490; 510; 532; 555; 589; 625; 665; 683 and 710nm).

A hyperspectral sensor (ASD FieldSpec® 3 VNIR spectrometer) measured every 3 μm within the range 350-1050nm and was used from the ship, at about two meters above the water surface. A SeaBird CTD profiler measured temperature, salinity and transmission. The measurements were accompanied with the analysis of pigments.

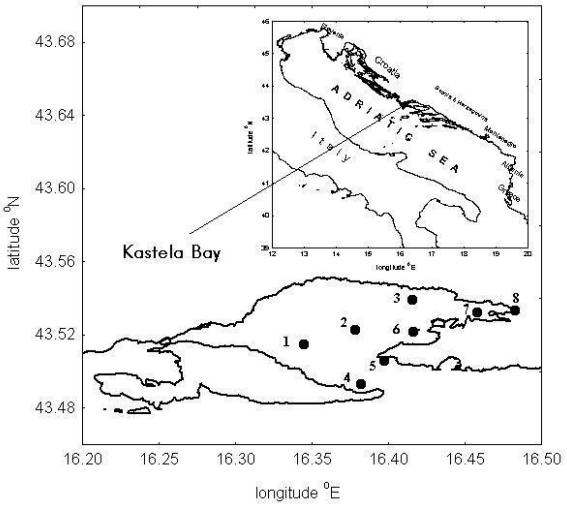


Fig. 1. Location of Kaštela Bay and stations in the eastern Adriatic

During two measurements qualitative and quantitative analyses of 17 different pigments were determined using a reverse-phase HPLC (High Performance Liquid Chromatography) method [1] from water samples filtered through Whatman GF/F filters and frozen until analyzed at -80° C.

The vertical structure of the water column during the cruises was stratified on 26-27 May, with thermocline developed to 7m. In mid October, the thermal structure was homogenous with 20°C temperature reaching the deepest part of the bay (35m). The environment was rather turbid during both measuring periods with transparencies between 11-12m in May and 6-10m in October.

After calculating optically weighted pigments for the surface layer, the spectral absorption curves were reproduced for the main pigments groups. Absorption spectra were digitized and with the use of spectral absorption data available in the literature [2], were normalized to pigment content to yield estimates of specific absorption curves, which were compared to calculated attenuation coefficients and reflectances.

Different in-situ pigment groups have had lesser influence to overall spectral reflectance curves because of the presence of dominant Chlorophyll type pigments.

Spectral reflectance curves have shown typically one peak in the visible spectrum between 490nm and 555nm, but at some stations, they were sometimes different for the two methods. However, examining the first differences, typically in both methods a distinct peak appeared between 555nm and 589nm (Figure 2). Higher order differences revealed some identical peaks, pointing to the similarity between the two methods.

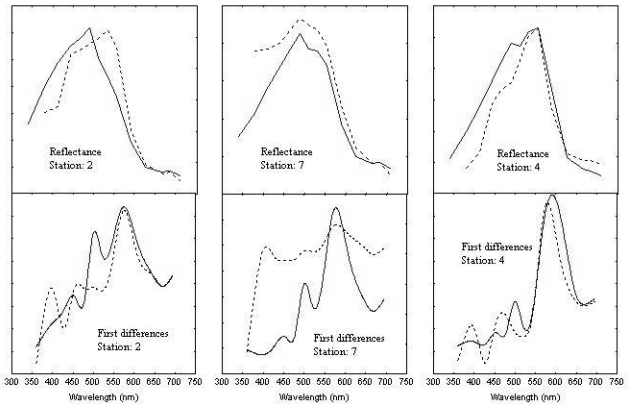


Fig. 2. Reflectances and first differences at some stations in the Kaštela Bay form optical profiler (full line) and from hyperspectral scanner (dashed line).

Additional analyses have explained to some extent the initial differences between reflectance spectra.

Vertical structures of optically active substances have had higher impact to profiler measurements, while the differences to the measurements from the air could have been caused by the higher sensitivity of the latter to particular conditions at the sea surface. In spite of the difficulties in distinguishing the water column impact and the bottom reflectance in the shallow region, the analysis has shown the potential for mapping of different coastal water types with both methods.

References
1 - Barlow R.G., Mantoura R.F.C., Gough M.A. and Fileman T.W., 1993. Pigment signatures of the phytoplankton composition in the northeastern Atlantic during the 1990 spring bloom. *Deep-Sea Res.* 40 (1/2): 459-477.
2 - Jeffrey S.W, Mantoura R.F.C. and Wright S.W. (eds.), 1997. Phytoplanton pigments in oceanography:guidlines to modern methods, Monographs on oceanographic methodology. SCOR, UNESCO Publishing, pp 1-661.

STRONG INTERNAL OSCILLATIONS FOUND IN THE CENTRAL SOUTH ADRIATIC PIT

M. Morovic [1]*, G. Beg Paklar [1], B. Grbec [1], I. Vilibic [1], D. Lucic [2] and F. Matic [1]
[1] Institute of Oceanography and Fisheries (IOF), Split, Croatia - morovic@izor.hr
[2] Institute for Marine and Coastal Research, University of Dubrovnik, Dubrovnik, Croatia

Abstract
The MEDUZA cruises in the south Adriatic Sea have acquired a number of oceanographic data in the deep South Adriatic Pit in summer 2003. Temperature, salinity and dissolved oxygen concentrations, together with transmission, pigments and optical parameters, were measured by two multiprobes in 6-h intervals during several days. Strong quasi-diurnal fluctuations of isothermal depths were observed, being in phase with local sea level, thus indicating internal waves as important phenomenon during this cruise.
Keywords: Adriatic Sea, Temperature, Circulation Models, Stratification

Although the general oceanography of the South Adriatic Pit is well studied in the past, the lack of high-resolution measurements prevented the investigations of a variety of processes that occur on the hourly timescales. Measurements in the frame of MEDUZA experiment tried to overpass that problem, at least over a local scale, as a large amount of data has been acquired at a single station (Figure 1) in short time intervals (approximately every 6 hours) between 23 and 28 July 2003. The deep sea CTD (Idronaut) multiprobe sampled the whole water column (1200m) once a day, while other measurements were performed with SBE25 multiprobe, reaching a maximum depth of 300m.

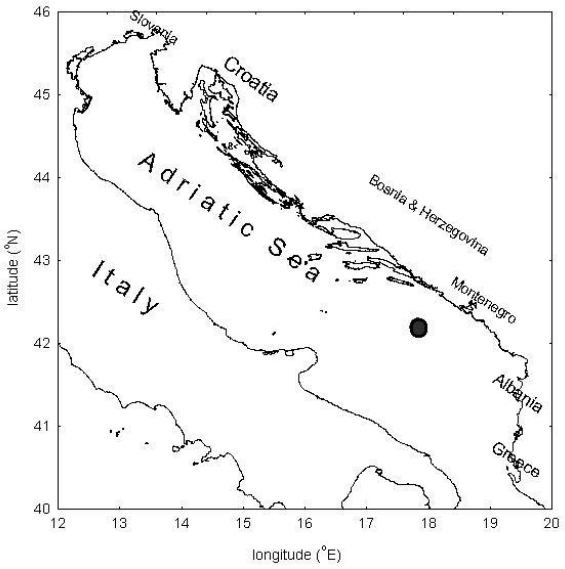


Fig. 1. Location of measurement station in the South Adriatic Pit

The cruise started with calm and clear weather, but at the fourth day strong SE wind and high waves prevented measurements for 36 hours, after which the fair conditions continued. Summer conditions in July 2003 were extremely warm and dry [1] with anomalously high air temperatures and low precipitation and runoff discharges. Surface sea temperatures were exceptionally high, reaching 27°C. Salinity was generally high in the whole water column. Thermocline was strongly developed at several tens of meters as expected. Below the thermocline, isothermal layers fluctuated unexpectedly strongly (10 m or even more) between the measurements (Figure 2).

As lower salinity waters have resided above the thermocline, the pycnocline was strengthened by the haline effect. The fluctuations of the pycnocline have a clear resemblance to the internal waves. The type of internal waves is hard to obtain as the measurements were too short, sparely for capturing such waves. However, the sea level fluctuations observed at the Bari and Dubrovnik tide gauges were in phase with the fluctuations. Also, high vertical oscillations in thermal structure were observed especially in deep layers (up to 120 m), pointing to the internal tides as a process that generated the oscillations.

The observed fluctuations were strong in the deep layers and attenuated towards the surface. Previously, strong isopycnal oscillations on diurnal and semi-diurnal periods has been found along the South Adriatic Pit northwest perimeter [2], being resonantly amplified by the topography [3]. However, the diurnal oscillations are found to be excited by the diurnal oscillations of see breeze winds during some of strong pycnocline oscillations [3], found to be as much as important as the tidal force. Therefore, both forces should be included in assessing the origin of the oscillations found in the deep South Adriatic Pit through targeted numerical modelling studies.

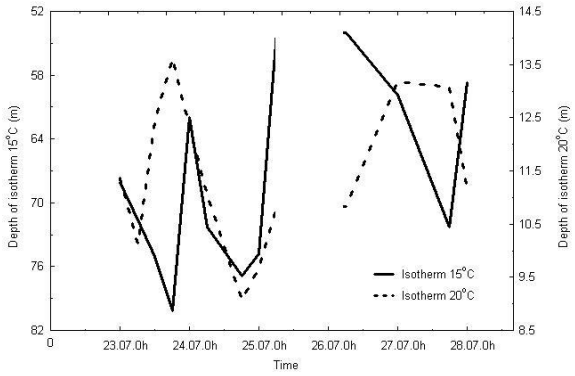


Fig. 2. Vertical oscillation of isotherms

These vertical fluctuations in the water column impacted a variety of properties from temperature and light transmission to chlorophyll maximum. Changes in optical parameters are known to be caused by depth rearrangement of phytoplankton throughout the day, but the physical processes may be quite important as well. This also applies to the observed daily vertical migration of zooplankton species found to be also remarkable [4], some of these presumably related to physical processes too.

References
1 - Grbec, B., Vilibic, I., Bajic, A., Morovic, M., Beg Paklar, G., Matic, F., Dadic, V., 2007. Response of the Adriatic Sea to the atmospheric anomaly in 2003. *Ann. Geophys.*, 25: 835-846.
2 - Orlic, M., Beg Paklar, G., Dadic, V., Leder, N., Grbec, B., Matic, F., Mihanovic, H., Morovic, M., Pasaric, M., Pasaric, Z., Vilibic, I., 2006, Internal Tidal Hydrodynamics and Ambient Characteristics of the Adriatic (ITHACA) Report on the third year of work, 106 pp.
3 - Mihanovic, H., Orlic, M., Pasaric, Z., 2006. Diurnal thermocline oscillations driven by tidal flow around an island in the Middle Adriatic. *J. Marine Sys.*, 78: S115-S168.
4 - Lucic, D., Benovic, A., Morovic, M., Batistic, M., Onofri, I., 2009. Diel vertical migration of medusae in the open Southern Adriatic Sea over a short time period (July 2003), *Marine Ecol.*, 30: 16–32.

ASPECTS OF THE SURFACE TYRRHENIAN SEA SUMMER CIRCULATION

Ernesto Napolitano [1]*, Roberto Iacono [1], Salvatore Marullo [1] and Vincenzo Artale [1]
[1] ENEA CR-Casaccia, Rome, Italy - ernesto.napolitano@enea.it

Abstract

A preliminary assessment of the Tyrrhenian Sea surface circulation of summer 2009 is given, based on the results of an operational ocean model, recently developed at ENEA. The numerical simulations reveal a complex circulation structure in the eastern part of the basin, that organizes around several well-defined quasi-permanent gyres. Comparison with altimeter data shows that these gyres are robust features of the summer circulation.

Keywords: Tyrrhenian Se, Models

Introduction

The Tyrrhenian Sea (TS), the main Italian sea, is a deep basin, with complex bathymetry, whose circulation is not yet fully understood. Although local wind forcing certainly plays an important role, the basin dynamics is also affected by the exchanges occurring at the three openings (Sardinia and Sicily Straits, Corsica Channel). In this work, we focus, in particular, on the role of the inflow of Atlantic water (AW) on the surface circulation of the basin. The main tool used is a high-resolution (1/48°, 40 sigma levels) operational model of the TS circulation, developed in the context of the PRIMI Project. This model takes initial and boundary data from MFS [1], and is forced by surface fluxes obtained from ECMWF data.

Results

Figure 1 shows the average 2009 summer surface (at 75 m depth) velocity field resulting from the analyses produced by the operational system, where some well-defined cyclonic and anticyclonic structures have been numbered from 1 to 6. Together with some established patterns, such as the Bonifacio cyclone-antyciclone system, the figure shows some interesting aspects of the circulation that have apparently not been stressed in previous descriptions. The first is the fact that the northward stream of AW entering the basin (known from previous numerical studies, e.g., [2]) bifurcates at about 41° N, with a branch recirculating southward around a very wide cyclonic region (6), and another one circling around the Bonifacio gyre and finally leaving the basin through the Corsica Strait. Contrary to previous descriptions (see, e.g., the classical works [3]), there is no northward AW flow along the Italian coast.

To the east of 6, there is a wide anticyclonic cell that occupies the whole eastern part of the TS, meandering around several well-defined eddies, the cyclone-anticyclone couples 1-2 and 4-5, and the anticyclonic area 3. These structures are present, with some variability, over the whole season. Although recent work suggests a complicated dynamics in the area, this is the first time that such a detailed structure of the circulation has been highlighted. We also note that the anticyclonic structure 1 may be related to the gyres recently described in [4].

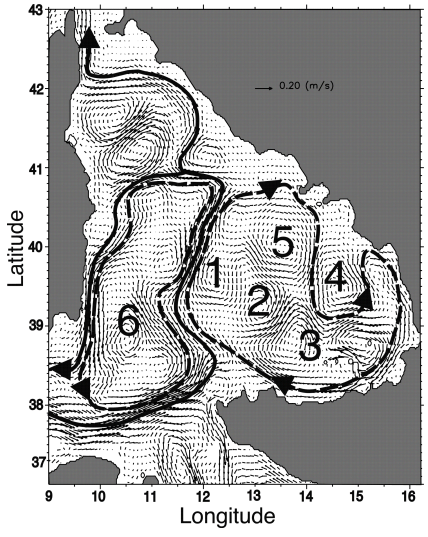


Fig. 1. Velocity field at 75 m produced by the operational model (2009 summer average)

The circulation in the eastern TS is probably mostly determined by the interaction between the local wind stress (that is typically anticyclonic in summer) and the complex topography. However, the fact that the western boundary of the anticyclonic cell is adjacent to the northward AW stream that flows through the central part of the basin suggests that this stream may also contribute to the eastern circulation, and to the associated vortical structures, through exchanges of momentum and vorticity.

It is natural to wonder whether the structures simulated by the model during 2009 are robust features of the summer circulation. To give a first answer to this question, we have analysed the SALTO-DUACS altimeter data provided by AVISO (http://www.aviso.oceanobs.com/duacs/), and we show in Figure 2 the summer average of the absolute dynamic topography over the whole period 1993-2008. The comparison seems excellent, since all the main structures appearing in the numerical results have their counterpart in the altimeter map, with close shapes and positions.

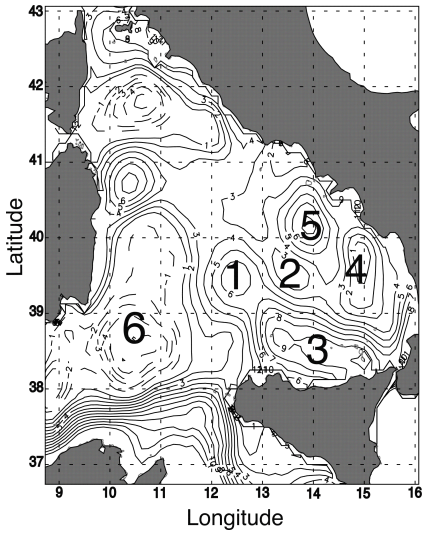


Fig. 2. Absolute dynamic topography by AVISO (1993-2008 summer average)

References

1 - Tonani M, Pinardi N., Dobricic S., Pujol I. and Fratianni C., 2008. A High-resolution free surface model of the Mediterranean sea, *Ocean Sci.*, 4: 1-14.

2 - Korres G., Pinardi N. and Lascaratos A., 2000. The ocean response to low-frequency variabilità in the Mediterranean sea. Part I: Sensitivity experiments and Energy analysis, *J. Climate*, 13 (4): 705-731.

3 - Krivosheya V.G. and Ovchinnikov I.M., 1973. Peculiarities in the geostrophic circulation of the waters of the Tyrrhenian Sea. *Oceanology*, 13: 822-827.

4 - Budillon G., Gasparini G.P. and Schroeder K., 2009. Persistence of an eddy signature in the Central Tyrrhenian Basin, *Deep-Sea Res. II*, 56: 713-724.

THERMOHALINE CHARACTERISTICS OF THE MEDITERRANEAN DEDUCED FROM ARGO DATA IN 2000-2009 (STATISTICAL ANALYSIS)

Giulio Notarstefano [1]* and Pierre-Marie Poulain [1]

[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale- OGS- Trieste, Italy - gnotarstefano@ogs.trieste.it

Abstract

Since 2000, numerous Argo floats have been deployed in the Mediterranean Sea under various programs and by different institutions/countries. Different cycling and sampling characteristics have been chosen to monitor this marginal sea, including cycles of 5 to 10 days, parking depths at 350 m and maximum profiling depths between 700 and 2000 m. This work contains the description of the thermohaline variability obtained using all the historical Argo data in the Mediterranean. The intrinsic variability of the temperature and salinity is described for most of the Mediterranean sub-basins by means of monthly statistics. The temporal decorrelation scales of temperature and salinity following floats are also estimated.

Keywords: Temperature, Salinity

Data and methods

In total, 88 Argo floats have been operated in the Mediterranean Sea between December 2000 and June 2009 (more than 7700 CTD profiles), out of which 27 correspond to the MFSTEP project [1]. The maximum density of floats was obtained in May 2006 with 31 floats running simultaneously. The following sub-basins were relatively well sampled by the floats: Catalan, Algerian, Ligurian, Tyrrhenian, Ionian, Cretan and Levantine. The Alboran and Aegean seas and the Sicily Channel area have limited Argo data. No data are available in the Adriatic Sea.

Thermohaline characteristics in the Mediterranean sub-basins

The following statistics have been calculated using the above-mentioned Argo data in the Mediterranean sub-basins:

• number of observations, mean and standard deviation of potential temperature (θ) and salinity (S) near 0, 600 and 2000 m;

• number of observations, mean and standard deviation of θ and S near depth of salinity maximum;

• depth of salinity maximum.

The mean S at the depth of salinity maximum is displayed versus time in Figure 1.

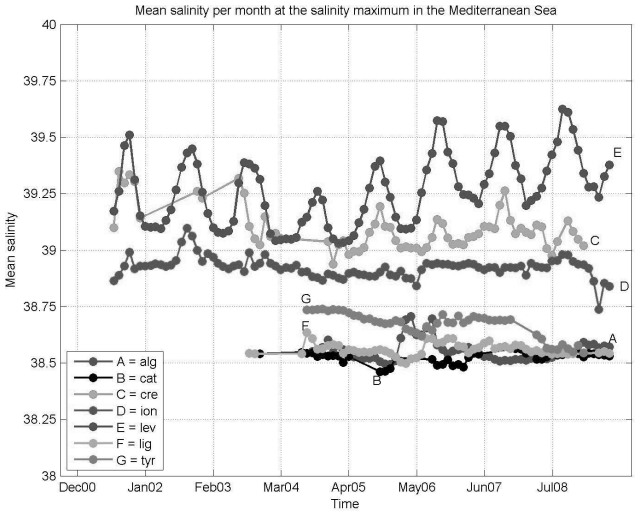


Fig. 1. Monthly mean of S at the salinity maximum in the Mediterranean sub-basins between December 2000 and June 2009.

Decorrelation scales of temperature and salinity

The time-lagged auto-correlations of θ and S at selected depths were calculated to estimate the decorrelation scales following the floats. For each float, a linear trend was removed from the data time series before computing the auto-correlation, in order to have a realistic measure of the data decorrelation. The auto-correlations of θ (Figure 2) and S are computed, by using a time step of 5 days. The Lagrangian integral time scale is computed by integrating to the first zero crossing of the autocorrelation function.

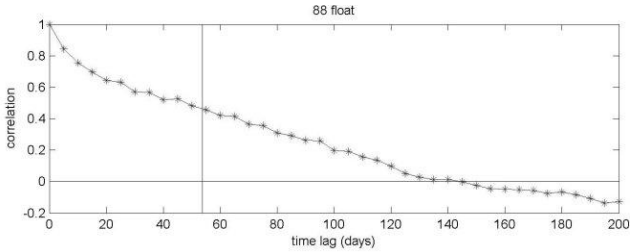


Fig. 2. Auto-correlation of temperature at 600 m versus time lag and integral time scale (vertical bar) for all the floats in the Mediterranean (trend is removed from the time series before computing the correlation).

Conclusions

Using the Argo data in the Mediterranean between December 2000 and June 2009, we have shown that:

• the Levantine sub-basin is in general the most populated with data spanning continuously between June 2001 and June 2009;

• the potential temperature exhibits a seasonal cycle near the surface in all the sub-basins, as well as the salinity in the Cretan and Levantine sub-basins;

• the characteristics of the temporal evolution of potential temperature and salinity at 600 and 2000 m show that the sub-basins can be mainly grouped in western and eastern sub-basins;

• trends are evident in the time series of monthly averaged temperature and salinity for some sub-basins, but their interpretation should be very cautious due to the non-uniform sampling of the floats, both in space and time;

• at 600 m the correlation coefficient for the potential temperature decreases to 0.84 after 5 days, and to 0.75 after 10 days. The zero-crossing occurs after about 140 days, whereas the Lagrangian integral time scale is about 60 days.

References

1 - Poulain P.-M., Barbanti R., Font J., Cruzado A. , Millot C., Gertman I., Griffa A., Molcard A., Rupolo V., Le Bras S. and Petit de la Villeon L., 2007. MedArgo: a drifting profiler program in the Mediterranean Sea. *Ocean Sci*., 3: 379-395.

EXTREME CONDITIONS IN THE STRAIT OF ISTANBUL (BOSPHORUS)

E. Okus [1], H. Altiok [1]*, A. A. Yilmaz [2], S. Ovez [3], S. Tas [1], N. Kiratli [1], A. Yuksek [1], N. Yilmaz [1], A. E. Muftuoglu [1] and H. I. Sur [1]
[1] Institute of Marine Sciences and Management, Istanbul University, 34116, Turkey - altiokh@istanbul.edu.tr
[2] Michigan State University, Michigan, USA
[3] Istanbul Technical Universty, Istanbul, Turkey

Abstract

The extreme conditions in the Strait of Istanbul are investigated based on observation of the chemical and bacteriological parameters together with hydrographic and current measurements. The upper and lower layer blockages occurred in 2003 at the strait which has a maximal exchange flow system. The distributions of the fecal coliform, nutrients, total suspended solids and dissolved oxygen along the strait during the blocking events indicate the behavior of the materials and its transportation in the strait.

Keywords: Bosphorus, Nutrients, Bacteria, Hydrography

The Strait of Istanbul (Bosphorus) is a narrow, long and shallow channel which connects the Marmara Sea and the Black Sea. It has a two-layer exchange flow system. The upper layer with ~18 psu flows from the Black Sea and the lower layer with ~38 psu flows from the Sea of Marmara [1, 2]. The average volume fluxes of the layers (600 $km^3 year^{-1}$ in the upper layer, 300 $km^3/year^{-1}$ in the lower layer) were calculated in terms of the salt and water budget of the Turkish Sea Straits [1, 3]. However, instant measurements of the volume fluxes change in a wide range since atmospheric conditions determine the flow exchange [4]. Blocking of the upper or lower layer are the extreme conditions in the strait. In this study both types of extreme conditions in the strait are presented. The two layer exchange flow in the Strait of Istanbul plays an important role on the environmental problem in the region. The discharge of waste water from the city of Istanbul has been eliminated by taking advantage of the strait flow structure. The volume fluxes and transport of materials between the Black Sea and the Sea of Marmara and renewal time of water and material in these seas mainly depend on exchange characteristics in the strait. Reliable estimates of these exchanges can be made only from data collected systematically and in a long term period including extreme conditions in the region.

The CTD (conductivity temperature depth) and ADCP (acoustic doppler current profiler) data were collected in the Strait of Istanbul in February and October 2003 by R/V ARAR of the Istanbul University, Institute of Marine Science and Management (IMSM-IU) The seawater samples were pretreated with persulphate digestion and analyzed by autoanalyser for total nitrogen (TN) and total phosphorus (TP) [5]. Among the bacteriological indicators of pollution, fecal coliform (FC) was studied by membrane filtration technique [6].

The lower layer blockage occurred in February 2003 when the strong northerly winds blew during several days (Figure 1). In the northern exit of the strait temperature and salinity were almost constant in the water column and its current directed to the south. The dissolved oxygen (DO) and total suspended solid (TSS) values were also homogenous throughout the surface to the bottom. Although the total nitrogen, total phosphorus and FC generally increased with depth till bottom due to the continuous deep discharge flow at the Strait of Istanbul [7], the vertical profile of the nutrients and FC were homogenous through the water column and bottom values were close to surface values during the lower current blockage. In the southern exit of the strait, the lower layer detected several meters in the bottom. Therefore, the deep discharge was blocked at the southern exit of the strait and could not reach to the northern exit during the lower layer blockage.

The upper layer blockage occurred in October 2003 when the strong southerly winds were dominant (Figure 1). Although salinity profiles at both exit of the strait indicated two-layer structure the current directions of the water column were the same in these two layers. Moreover the interface between the two layers was very thick and it was located upper depth along the strait. The bottom values of DO, TSS, TN, TP and fecal coliform were higher than the normal conditions and the beginning of the increase was above the halocline, primarily controlled by the velocity of the current flow during the upper layer blockage.

The blocking of the current flow is an extreme condition for the strait hydrography. The lower layer blockage is critical since the deep discharges given to the lower layer current flow are also blocked and the discharge diffuses to a larger zone in the water column, which might also affect the surface water quality. However, these extreme conditions instantly develop during strong meteorological events such as persistent northern winds encompassing rather small period of the whole year.

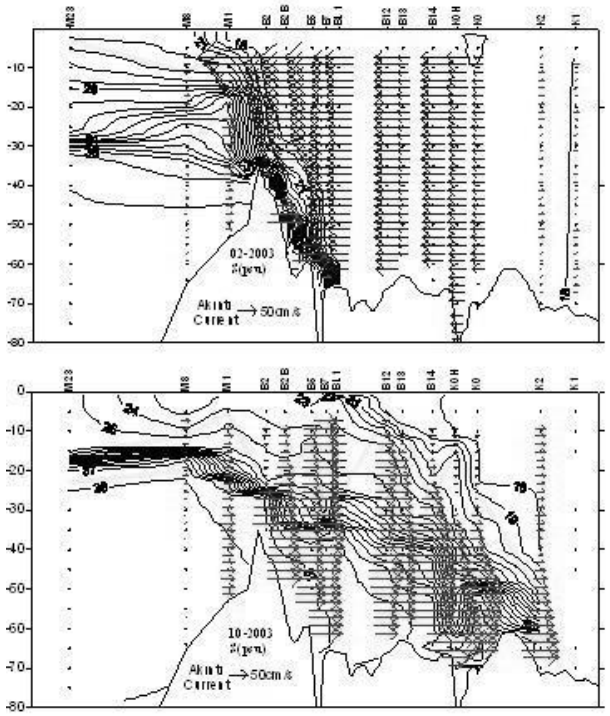


Fig. 1. Lower and upper layers blockage

References

1 - Ünlüata Ü., Oguz T., Latif M., Özsoy E., 1990. On the physical oceanography of the Turkish Straits. In: Pratt L.J. (ed.). The physical oceanography of sea straits. Kluwer Academic Publishers, Boston, pp 25-60.

2 - Yüce H., 1996. Mediterranean water in the Strait of Istanbul (Bosphorus) and the Black Sea exit. *Estuar. Coast. Shelf S.*, 43: 597-616.

3 - Besiktepe S.T., Sur H.I., Özsoy E., Latif M.A., Oguz T. and Ünlüata Ü., 1994. The circulation and hydrography of the Marmara Sea. *Prog. Oceanogr*. 34 (4): 285-333.

4 - Oguz T., Özsoy E., Latif M., Sur H. I. and Ünlüata Ü., 1990. Modeling of Hydraulically Controlled Exchange Flow in the Bosphorus Strait. *J. Phys. Oceanogr*., 20: 945-965.

5 - Grasshoff K., Ehrhardt M. and Kremling K., 1983. Methods of Seawater Analysis, Verlag Chemie, Weinheim

6 - APHA, AWWA and WPCF, 1980. Standard Methods for the Examination of Water and Wastewater, 17th Edition. American Public Health Association, Washington, D.C.

7 - Okus E.,Yilmaz A., Yüksek A., Tas S. and Tüfekçi V., 2002. Nutrient distribution in the Bosphorus and surrounding areas. *Water Sci. Technol.*, 46 (8): 59–66

EFFECTS OF THE ASSIMILATION OF SEA LEVEL ANOMALY IN THE SICILY CHANNEL REGIONAL MODEL

Antonio Olita [1]*, Roberto Sorgente [1], Leopoldo Fazioli [1] and Alberto Ribotti [1]
[1] CNR-IAMC U.O.S. di Oristano, Loc. Sa Mardini Torregrande(OR), Italy - a.olita@iamc.cnr.it

Abstract
Analyses assimilating remotely sensed sea level anomaly observations have been performed in the Sicily Channel for 2008 using a 3D eddy-resolving regional model. The output fields have been compared with those of a free run covering the same period. As expected the assimilation has a substantial effect on the spatial features produced. The root-mean-square difference map puts in evidence the areas where assimilation has larger influence.
Keywords: Circulation, Models, Sea Level

Preface
Operational oceanography systems encompass three main components: systematical observational data, numerical models, and robust data assimilation modules. The Sicily Channel Regional Model (SCRM), a nested eddy-resolving 3D model based on Princeton Ocean Model and developed during the Mediterranean Forecasting System projects, is the core of the system. Seasonal variability [1], inter-annual variability [2], and forecasting skills [3] have been verified in recent studies by means of the synergistic use of SCRM fields and observations. In order to provide the best estimate of the sea true state, the assimilation of along track sea level anomalies (SLA) has been implemented in the system. Two experiments, A1 (analysis) and A2 (free run), respectively with and without the assimilation of SLA, have been conducted simulating the year 2008.

Model setup
SCRM is driven at the surface by momentum, heat and water fluxes computed through the 6-hourly atmospheric fields (mean sea level pressure, air temperature at 2m, wind speed and direction at 10 m and cloud cover) by using the well known bulk formulae [4]. At the open boundaries, SCRM is nested with the coarse model MFS1671 [5] through an off-line one way nesting technique of the analyses daily mean fields of temperature, salinity and total velocity. The data assimilation software used is based on a 3D Variational scheme (OceanVAR) [6]. Vertical background error covariance is represented through Empirical Orthogonal Functions (EOFs), computed from the model outputs of a previous long-term simulation. Only the most significant EOFs are used. Horizontal covariance is modeled as a Gaussian function. The state vector contains all the state model variables (temperature, salinity, free surface elevation, velocity components), so the corrections are performed on all these variables. The 3D-VAR scheme finds its solution minimizing a cost function. The assimilated data is the Along Track Sea Level Anomaly (SLA) from Jason-1 satellite.

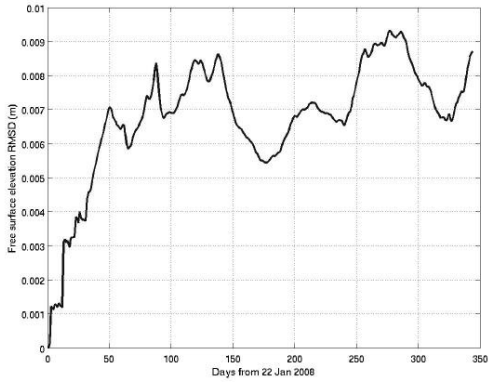


Fig. 1. Free surface elevation RMSD between experiments A1 and A2

Results
The Root Mean Square Difference (RMSD) time series of the free surface elevation shows the evolution of the SLA assimilation effects in time. A two months initial divergence of the two solutions is evident, during which the RMSD progressively increases. After this initial period the surface elevation RMSD ranges between 0.6 and 1 cm. Differences between the two experiments A1 and A2 are better evident by considering the variability of the spatial features produced. An useful way to locate the areas where the assimilation has a larger impact is representing the RMSD map of the surface elevation (Fig.2). Largest values of RMSD (2.5 cm) are found in the area off the Lybian coast, in the Ionian Sea and between Sardinia and Corsica.

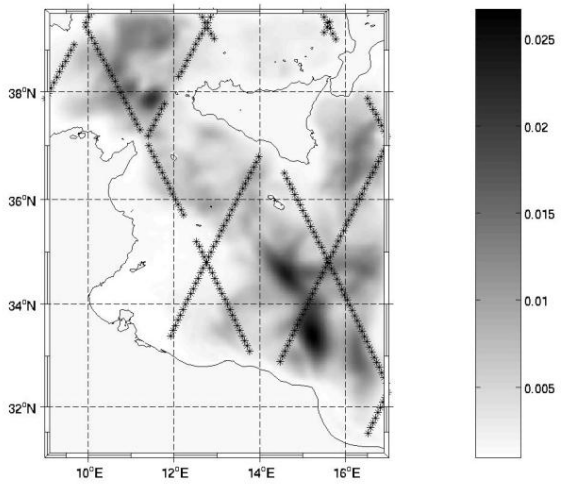


Fig. 2. RMSE map of the free surface elevation between experiments A1 and A2. Tracks of the assimilated SLA observations are also shown.

Final Remarks
Remotely sensed observations of sea-level anomaly have been assimilated into the SCRM by using a 3D Variational scheme. The system has been applied in a numerical experiment to examine the effects of the assimilation scheme. Changes observed in the surface elevation fields have a patchy distribution, which in first instance was found correlated to the presence/number of assimilated observations. The effects of such changes on surface circulation should be deeply investigated.

References
1 - Sorgente R., Drago A.F. and Ribotti A., 2003. Seasonal variability in the Central Mediterranean Sea circulation. *Ann. Geophys.*, 21: 299-322.
2 - Olita A., Sorgente R., Natale S., Gaberšek S., Ribotti A., Bonanno A. and Patti, B., 2007. Effects of the 2003 European heatwave on the Central Mediterranean Sea: surface fluxes and the dynamical response. *Ocean Sci.*, 3: 273-289.
3 - Gaberšek S., Sorgente R., Natale S., Ribotti A., Olita A., Astraldi M. and Borghini, M., 2007. The Sicily Channel Regional Model forecasting system: initial boundary conditions sensitivity and case study evaluation. *Ocean Sci.*, 3: 31-41.
4 - Castellari S., Pinardi N., and Leaman K., 1998. A model study of air-sea interactions in the Mediterranean Sea. *J. Mar. Sys.*, 18: 89–114.
5 - Pinardi N., Allen I., De Mey P., Korres G., Lascaratos A., Le Traon P.Y., Maillard C., Manzella G. and Tziavos C., 2003. The Mediterranean ocean Forecasting System: first phase of implementation (1998-2001). *Ann. Geophys.*, 21(1): 3-20.
6 - Dobricic S. and Pinardi N., 2008. An oceanographic three-dimensional variational data ssimilation scheme. *Ocean Modelling*, 22(3-4): 89-105.

INVERTED BAROMETER OVERSHOOT AND GREAT ADRIATIC SURGE OF 21 JUNE 1978

Mirko Orlic [1]*, Danijel Belusic [1], Ivica Janekovic [2] and Miroslava Pasaric [1]
[1] University of Zagreb, Faculty of Science, Andrija Mohorovicic Geophysical Institute, Zagreb, Croatia - orlic@olimp.irb.hr
[2] Rudjer Boskovic Institute, Center for Marine and Environmental Research, Zagreb, Croatia

Abstract
On the morning of 21 June 1978 exceptional sea-level oscillations, having a trough-to-crest height of 6 m and a period of 10-20 min, occurred in Vela Luka Bay. Slightly less pronounced variability was observed elsewhere along the east Adriatic coast and, with some delay, along the west coast. In this presentation one of the hypotheses put forward to interpret the event, the one relating it to a mesoscale air-pressure disturbance, is supported by results of the analysis of all the available data and of the runs performed with the state-of-the-art meteorological and oceanographic models.
Keywords: Adriatic Sea, Air-Sea Interactions, Coastal Models, Sea Level

On the morning of 21 June 1978 a tsunami-like event occurred in the Adriatic Sea. With the trough-to-crest height reaching 6 m in Vela Luka Bay on the Island of Korcula and exceeding 1 m in a number of places along both the east and west coasts of the Middle and South Adriatic, this was the most pronounced such event observed in the Adriatic in the 20th century. There were no casualties in Vela Luka, but the town was so heavily damaged that the state of emergency had to be proclaimed. The event was extensively commented in contemporary newspapers, along with the fact that it did not correspond with an equally dramatic process in either the atmosphere above the Adriatic or the earth below it. A dozen or so tide gauges operated in the Adriatic at the time, but although some of them did record intensified high-frequency variability, none was exposed to one of the sea-level maxima.

In the years following the event four different hypotheses on the generating mechanism have been proposed, with two of them finding the cause at the sea bottom and two in the atmosphere. The four hypotheses shared a common weakness: explanations of the relationship between the cause (earthquake-related bottom movement, landslide, cyclone, or atmospheric gravity wave) and the consequence (surge) were not supported by a proper modeling. In this presentation one of the hypotheses, the one relating it to a mesoscale air-pressure disturbance [1], is reconsidered by using all the available data as well as the state-of-the-art meteorological and oceanographic models. Careful analysis of the sea-level observations and measurements reveals that the sea-level heights at the east Adriatic coast were much larger than at the west coast and that the west coast oscillations mostly lagged behind the east coast variability [2]. A fresh look at the air-pressure data confirms the previous finding according to which a mesoscale atmospheric disturbance propagated at about 22 m/s in a northeastward direction above the area affected by surging, and also enables various timing errors in barograph records to be taken into account. Additionally, an analysis of a simultaneous wind record reveals that the disturbance lasted about 10 min.

The meteorological model employed (WRF-ARW) proves unable to reproduce the mesoscale disturbance coinciding with the surge, but shows that the background atmospheric conditions were favorable for the development of such disturbances. The oceanographic model ADCIRC-2DDI, forced by the air-pressure disturbance characterized by a 3 mbar increase, the shape of a boxcar function, and the other parameters as stated above, successfully reproduces sea-level variability in Vela Luka Bay reaching a few meters and thus surpassing the inverted barometer response by two orders of magnitude.

The enhancement appears to result from a four-phase process: (1) the air-pressure disturbance travels from the west Adriatic coast to the mouth of Vela Luka Bay and generates a pronounced wave packet in the sea due to the speed of the forcing disturbance being close to the speed of shallow-water waves, (2) leading waves in the packet enter the bay and are amplified due to the funnel-shaped form of the basin, (3) the waves are reflected at the bay head, and (4) the waves return to the bay mouth, are partially reflected there, and are constructively superimposed on the waves entering the bay from the open sea. The model also suggests that elsewhere in the Adriatic the conditions were not so close to the resonant ones as in Vela Luka Bay and that the scattering due to variable bathymetry and reflection from the east Adriatic coast resulted in waves that returned towards the west coast and generated considerable sea-level activity there. Comparison of the empirical sea levels with the modeled values carried out for the whole area strongly supports the rather weak mesoscale atmospheric disturbance as an adequate forcing agent.

The present interpretation of the Vela Luka surge of 1978 invokes only the ray theory and therefore departs somewhat from the interpretation of other similar Adriatic events, e.g. those observed in Stari Grad and Mali Ston Bays in 2003 [3] and on the Island of Ist in 2007 [4], that was based on the ray theory in the open sea combined with the mode theory in the coastal basins.

References
1 - Orlic M., 1980. About a possible occurrence of the Proudman resonance in the Adriatic. *Thalassia Jugosl.*, 16, 1: 79-88.
2 - Orlic M., Belusic D., Janekovic I. and Pasaric M., 2009. Fresh evidence relating the Adriatic surge of 21 June 1978 to mesoscale atmospheric forcing. *J. Geophys. Res.*, submitted.
3 - Vilibic I., Domijan N., Orlic M., Leder N. and Pasaric M., 2004. Resonant coupling of a travelling air pressure disturbance with the east Adriatic coastal waters. *J. Geophys. Res.*, 109, C10001: doi:10.1029/2004JC002279.
4 - Sepic J., Vilibic I. and Belusic D., 2009. Source of the 2007 Ist meteotsunami (Adriatic Sea). *J. Geophys. Res.*, 114, C03016: doi:10.1029/2008JC005092.

A MOORED PROFILER FOR OCEANOGRAPHIC RESEARCH AND ENVIRONMENTAL MONITORING

Alexander G. Ostrovskii [1] and Andrey G. Zatsepin [1]*

[1] P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences, Nakhimovsky Pr. 36, Moscow 117997, Russia - zatsepin@ocean.ru

Abstract

This presentation concerns the research and development of the ocean moored profiler Aqualog. This technique allows a user to obtain regular time series of oceanographic data at fixed geographical location by using conventional oceanographic probes, which are transported by a special carrier that moves vertically between surface and bottom of the sea.

Keywords: Monitoring, Currents, Deep Waters

A moored profiler is a useful tool for multidisciplinary investigations such as water exchange and deep current structure. In the framework of conducting oceanographic research the profiler is a useful tool for field investigations of the variability of both biotic and abiotic parameters of the sea environment from a few hours to a few months. The estimation of the short-period variability and its impact on the generation of mixing is possible on the basis of regular probing during a sufficiently long time. To assess the dynamics of barotropic and baroclinic waves, eddies and wave-eddy structures and their role in the water transfer and exchange, it is necessary to observe the spatial peculiarities of hydrophysical parameters. This makes it necessary to conduct simultaneous probing by a set of profilers in a number of sea locations. Finally, a topical task is revealing climate signals in multi-year series of oceanographic data at fixed locations in sea basins. To achieve these objectives it is important to get regular and homogeneous ensembles of the observational data.

A new moored profiler named Aqualog was designed in P.P. Shirshov Institute of Oceanology in 2005-2009 (Fig. 1). It was tested at field trials in the Black Sea and the Caspian Sea. The profiler is built to carry a load of modern oceanographic instruments. It moves down and up along the mooring line as a sea 'lift' carrying various instruments including FSI Excell 2" Micro CTD probe, Nortek Aquadopp current meter, and AANDERAA Oxygen Optode 4330F. The payload of this sea elevator may also comprise other environmental probes e.g., fluorimeter and turbidimeter. The profiler mooring line is made of stainless steel wire that allows a user to extend the maintenance period of the mooring system up to several months. The programmable hardware of the profiler allows to set up an automatic operation algorithm (variable movement speed, time and period of the profiling, etc.).

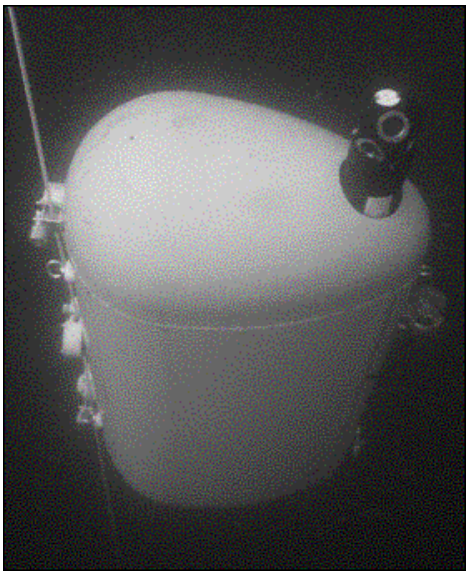


Fig. 1. The profiler in the Black Sea waters. The profiler is photographed from above under a movement limiter at a depth of approximately 7 m right before another downward/upward profiling cycle. The vertically stretched mooring line is passed through the drive-wheel on the profiler. In the upper right part of the profiler an acoustic Doppler current meter Nortek Aquadopp is shown.

So far the typical depth range of Aqualog's operation was 5–600 m. With a titanium instrument housing the maximum operation depth reaches out to 3000 m. Vertical speed can be set up within 0.05 and 0.3 m/s. The payload is up to 4 instruments; 1 slot is available for mounting an optional ocean probe. Weight in the air is 62 kg without the sensors or up to 75 kg with the sensors. Start and stop is by magnetic switch or as preprogrammed. There is a light indication of the system status. The total profiling distance is about 800 km in still waters for the profiler with lithium battery pack. The Aqualog has an energy resource sufficient for profiling the water column in the programming regime for up to several months.

The custom measurement instruments are high-precision, stable and fast-response. When the carrier is moving with the speed of 0.1 m/s the vertical profiles are measured with a vertical resolution of 0.05 m for pressure, conductivity and temperature (FSI Exell 2" Micro CTD), 0.6 m for the current speed (Nortek Aquadopp) and 0.8 m for the dissolved oxygen (AANDERAA Oxygen Optode 4330F).

The Aqualog was successfully tested during expeditions into the Black and Caspian Seas in 2005-2009. By using the Aqualog new data was obtained about inertial oscillations, mesoscale variability, and vertical exchange in the coastal waters. Over the north-eastern Black Sea shelf, the depth of the seasonal thermocline, the vertical gradient of density driven by temperature distribution and the current velocity gradient in the thermocline as well as the vertical exchange coefficient, all are substantially modulated by inertial oscillations and mesoscale vortices. Moored autonomous profiling stations located at a fixed geographical point represent the most preferable technical means for regional marine environmental monitoring. A moored profiler station inhibits a smaller risk of loss and facilitates technical services including power batteries and maintenance of the sensors.

This study was supported by the Russian Foundation for Basic Research grants 05-05-64927, 06-05-08092-ofi, 06-05-02105-e_k, 08-05-12046-ofi.

References

1 - Ostrovskii A.G., Zatsepin A.G., Derevnin V.A., Nizov S.S., Poyarkov S.G., Tsybulskiy A.L. and Shvoev D.A., 2008. Akvazond moored automatic measuring system for vertical profiling of the marine medium, *Oceanology*, 48: 275–283.

OPERATIONAL FORECASTING FOR THE NORTHERN LEVANTINE, BLACK SEA AND THE TURKISH STRAITS SYSTEM: PROBLEMS AND PROSPECTS

Emin Özsoy [1]*, Adil Sözer [1], Hazem Nagy [1] and Murat Gündüz [1]
[1] Institute of Marine Sciences, Middle East Technical University, Mersin, Turkey - ozsoy@ims.metu.edu.tr

Abstract
Operational coastal ocean forecasts are developed for the seas encircling the Anatolian peninsula (Turkey) includig the northern Levantine Sea, Black Sea and the Turkish Straits System (TSS). An observing system of real-time coastal measurements has also been developed. Operational coupled ecosystem models are also aimed, with encouraging first results. The observational system consists of coastal sea-level and meteorological stations and an ADCP system in the Bosphorus Strait. The problems and prospects of forecasting and experiences to date are described.
Keywords: Straits And Channels, Black Sea

Coastal ocean forecasts for the northern Levantine Sea have been developed, and have been operational since 2005, driven by high resolution atmospheric forcing and nested in the MFS (Mediterranean Forecasting System) regional forecast models [1]. The model has a horizontal resolution of 1.35 km and 28 vertical sigma levels. Recently the forecast modelling has been updated to include the effects of major rivers in the Cilician basin of the northeastern Levantine, supplying the main fresh water inputs to the region, contributing significantly more than the present discharge of the Nile river into the Levantine Sea. Mersin Bay and Iskenderun Gulf, connected through a wide shelf region in the northeastern corner of the Levantine Sea alone receive most of the fresh water, therefore making it a region of freshwater influence (ROFI). On the other hand, the westerly flowing Asia Minor current is an often unstable jet that meanders and sheds eddies in the northern Levantine, and especially in the Cilician Basin, connected to the shelf that receives large amounts of fresh water, which are then dispersed by the eddies and meanders. Satellite data display the influence region of the dispersion pattern. A deep current, underlying the Asia Minor current, is generated along the steep shelf region to the west as the flow over the sill between the Cypriot and Turkish coasts induces an overflow that veers to the north, steered by the slope topography. Levantine Intermediate Water formation, also observed in continuing experimental programs, has been captured in the forecasts in several early spring cases. Convective mixing in the shallow shelf area of the Mersin Bay and Iskenderun Gulf preceeds the leakage of this water first to the west and later to greater depths. The construction of an operational coupled ecosystem model has been tested with promising first results, but presently remains somewhat prohibitive in terms of computer runtime requirements.

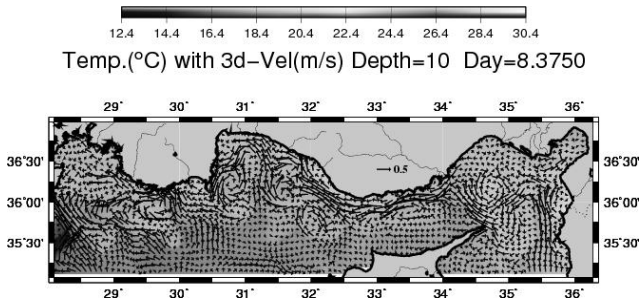


Fig. 1. Forecast sea surface temperature and currents at 90 hrs after 1st of January 2010, northern Levantine sea.

Operational forecasts have been developed for the entire Black Sea, using high resolution surface atmospheric fluxes of mass, momentum and heat, as well as the monthly fresh water fluxes of the major Black Sea rivers that dominate the behaviour of the system. Annual mean fluxes are specified at the Bosphorus with time relaxation. The model has a horizontal resolution of 2.5 km and 30 vertical sigma levels. The main double-gyre circulation of the Black Sea, the 'rim-current' structure, and major semi-permanent features such as the 'Sevastopol eddy' are well represented. The spreading of fresh water from the large rivers of the northwest shelf, primarily affects the shelf region, but also spreads to other parts of the Black Sea with the rim current.

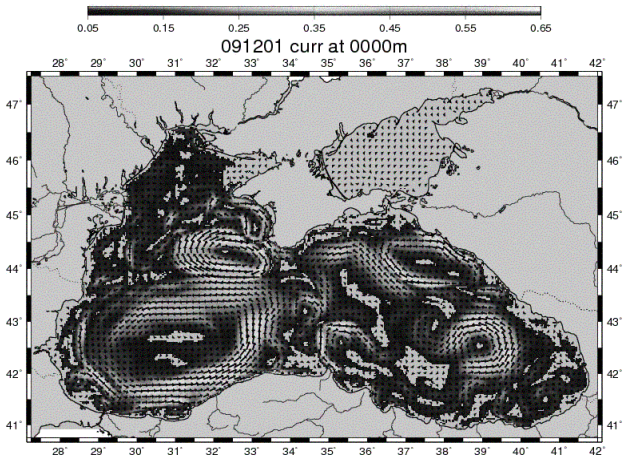


Fig. 2. Black Sea operational forecast for 1 December 2009.

The implementation of an operational model for the Turkish Straits is a formidable task, because of the major problems of multi-scale coupling between different elements of the system and with the adjacent basins. The approach for a first level of understanding has been based on decoupling and studying separate parts, which individually have sufficient complexity. Despite the prohibitive requirements for resolution and physical processes representation, a reasonably resolving model of the Turkish Straits System is also attempted, and has so far yielded promising results.

A coastal observation network consisting of sea-level and surface meteorology sensors at 14 stations along the coasts and an ADCP profiling station in the Bosphorus has been set up to collect real-time data [2]. The system has been operational for about 2 years, and is aimed to complement the forecasting systems.

References
1 - Özsoy, E. and Sözer, A., 2006. Forecasting circulation in the Cilician Basin of the Levantine Sea, *Ocean Sci. Discuss*., 3: 1481–1514.
2 - Özsoy E., Sözer A., Gündüz M., Yücel A., Yagci B., Mert I., Yildiz H., Simav M. and Elge, M., 2009. Meteorology and Oceanography Network of Excellence (MOMA) Observation and Forecast Systems, USMOS 09, National Defense Appications Modelling and Simulation Conference, Ankara, 17-18 June 2009, 27pp. (in Turkish).

COASTAL CIRCULATION OFF THE CITY OF MARSEILLE FROM 3D MODELING AND OBSERVATIONS

I. Pairaud [1]*, J. Gatti [1], N. Bensoussan [2], R. Verney [3] and P. Garreau [3]

[1] Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER), BP330, 83507 La Seyne sur Mer Cedex, France - ivane.pairaud@ifremer.fr

[2] Laboratoire de géochimie des Eaux, UMR 7154, Institut de Physique du Globe de Paris, Batiment Lamarck, 35 rue Hélène Brion, Case courrier 7052, 75205 Paris cedex 13, France

[3] Institut Francais de Recherche pour l'Exploitation de la Mer, BP 70, 29480 Plouzane, France

Abstract

In the framework of the protection and management of coastal waters in the Mediterranean Sea, the city of Marseille (south of France) has been chosen to study the fate of chemical contaminant inputs and its impact over the adjacent marine ecosystems. A numerical tool is developped, based on the coupling of a hydrodynamical model, a sediment model, a biological model and a model of chemical contamination. The present work deals with the validation of the hydrodynamics' compartment by comparisons with observations, which constitutes a prerequisite for the future operational system.

Keywords: Coastal Models, Circulation, Coastal Processes, Gulf Of Lions

The geomorphology and density of contaminant-generating industries of the city of Marseille is highly representative of large modern mediterranean cities. Marseille was thus chosen as a laboratory area for the development of a numerical tool dedicated to the assessment of the chemical contaminant raw inputs (from city to sea) and exports (from midsea to open sea) from the city. This tool is developed based on the coupling of a hydrodynamical model, a sediment model, a biological model and a model of chemical contamination. The present work deals with the validation of the hydrodynamics' compartment, based on the comparison with data issued from observational networks and campaigns at sea for the years 2007 and 2008.

The high resolution 3D coastal ocean model MARS3D (for 3D hydrodynamic Model for Applications at Regional Scale) has been applied to forecast the oceanic circulation off Marseille from the Rhone river to the Cap Sicié (south of France). For the RHOMA configuration (Fig 1), realistic numerical simulations were performed for the years 2007 and 2008, with forcing by the Rhone river, meteorological fields and by the surrounding general circulation known to be strongly constrained by the Northern Current.

A lot of observations providing the stratification and currents off Marseille were acquired from in situ oceanographic networks and from vessel cruises during the last decade. In order to validate the nested forecasting system, quantitative comparisons between observations and model results were perfomed. Statistics over long time series of temperature at three moorings (SOMLIT and MEDCHANGE stations) were computed to show the model skills in capturing the monthly to seasonal variability of the thermal structure. This comparison also shows that the model reproduces well the observed features associated with the shelf processes.

In particular, the wind strongly constrains the shelf circulation off Marseille [1] and the model reproduces the cooling of the sea surface waters due to upwelling caused by a wind blowing parallel to the coast when the ocean is stratified (in summer and fall).

During the strong Rhone river discharge of June 2008, we reproduced an intrusion of the Rhone river diluted (low salinity) waters observed into the southern bay of Marseille for several days under westerlies and south-easterlies at the Frioul island station.

In addition to those forcings, the general circulation is also of great influence. Intrusions of the northern current off Cassis from the south of the domain are observed and reproduced by the model in winter, due to the penetration of meanders over the narrow eastern part of the shelf [2].

This study received support from the IFREMER METROC project sustained by the Marseille water agency, the GIRAC project and the PNEC-EC2CO MASSILIA project.

The authors gratefully acknowledge J. Garrabou and the Medchange program as well as JG Harmelin and the 'Parc-Marin de la cote bleue' for communication of the MEDCHANGE T time series. We are grateful to the staff of the SOMLIT (Service d'Observation en Milieu Littoral) national network for littoral observations of the INSU (Institut National des Sciences de l'Univers) for providing the data from the SOMLIT-Frioul Marseille station.

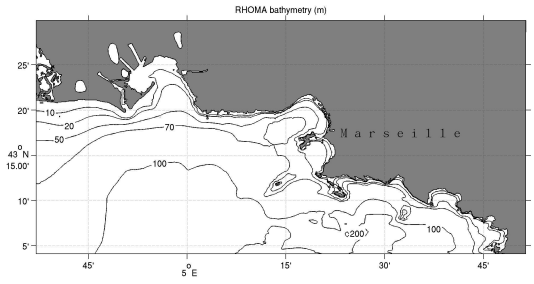


Fig. 1. Bathymetry of the RHOMA modeling domain.

References

1 - Pradal M. and Millet B., 2006. Spatial heterogeneity of wind forcing: application to artificial reef functioning influenced by the circulation in the bay of Marseilles. *C.R. Biologies*, 329(7): 541-550.

2 - Albérola C. and Millot C., 2003. Circulation in the french mediterranean coastal zone near Marseilles: the influence of wind and the Northern Current. *Cont. Shelf Res.*, 23: 587-610.

DEEP CANYON AND SLOPE SUSPENDED SEDIMENT TRANSPORT IN THE WESTERN GULF OF LIONS DURING THE 2006 INTENSE CASCADING PERIOD

A. Palanques [1]*, P. Puig [1], X. Durrieu de Madron [2], A. Sanchez-vidal [3], A. Calafat [3], C. Pascual [3], S. Heussner [2] and M. Canals [3]
[1] Institut de Ciencies del Mar (CSIS),08003 Barcelona, Spain - albertp@icm.csic.es
[2] Centre de Formation et de Recherche sur l'Environnement Marin, UMR 5110 CNRS-Université de Perpignan, France
[3] GRC Geociències Marines, Universitat de Barcelona, Spain

Abstract
The network of mooring lines deployed between 300 m and 1900 m depth along Lacaze-Duthiers and Cap de Creus canyons and the southern open slope allowed to study the water and sediment transport in the Western Gulf of Lions during the 2006 intense cascading period. The dense water and sediment transport reached down to 1900 m depth and was both through submarine canyons and along the southern open slope towards the Catalan Margin. Sediment transported by cascading came either from the shelf or from resuspension of sediments previously deposited at mid-canyon depths. Open-sea convection processes combined with deep cascading pulses also generated sediment transport at deeper slope regions.
Keywords: Continental Margin, Particle Flux, Sediment Transport, Gulf Of Lions, Deep Sea Processes

Dense shelf water cascading in the north-western Mediterranean has been identified as a major transport mechanism able to generate high sediment fluxes in submarine canyons [1, 2, 3] and in the basin during the coldest years [4]. It is known that dense shelf water flows can transport shelf particles and erode and reshape the seafloor, increasing suspended and bed load sediment transport as they progress across the outer shelf and upper continental slope. However, observations of the spreading of dense shelf water cascading across the entire continental slope are scarce and its effects on sediment transport towards the continental rise and basin are largely unknown.

The north-western Mediterranean is a region of dense water formation due to the effect of strong and persistent northern winds (Mistral and Tramontana). The formation occurs on the shallow inner shelf of the Gulf of Lions and at open-sea, preferably in the area known as MEDOC site. Over the continental shelf, the intense wind-induced evaporation and cooling produce cold dense water that eventually overflows the shelf and cascades down the slope, especially though the westernmost submarine canyons. The process occurring in the basin is characterized by open sea vertical convection, and mixing of surface water with warmer but saltier Levantine Intermediate Water [5].

Recent studies have demonstrated that most of the off-shelf suspended sediment transport in the Gulf of Lions occurs in its westernmost sector, preferentially through the Cap de Creus submarine canyon. Based on this previous knowledge, a focussed monitoring strategy was designed within the HERMES project, to better constrain the contemporary sediment transport processes in this region. A network of mooring lines equipped with current meters and turbidity sensors at 5 m above bottom were deployed between 300 m and 1900 m depth along the axes of the two Lacaze-Duthiers and Cap de Creus neighbor canyons, as well as across the southern open slope from October 2005 to October 2006 (Fig. 1).

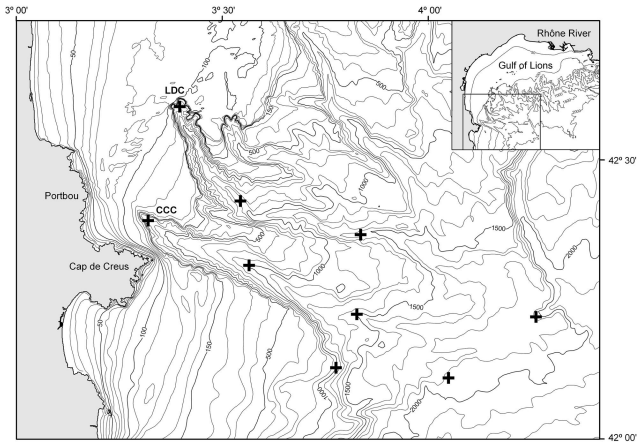


Fig. 1. Bathymetric map of the study area showing the location of the moored instruments. CCC: Cap de Creus Canyon. LDC: Lacaze-Duthiers Canyon.

Recorded data indicate that dense shelf water cascading was the main shelf-to-slope sediment transport process in the area, acting from January to April-May 2006. The dense water and sediment transport was not only through submarine canyons, but also along the southern open slope. The most important suspended sediment transport event was due to the intense cascading pulse occurring in January 2006, which produced a strong sediment flux increase along the Cap de Creus Canyon down to 1900 m depth and also along the open slope at 1000 m depth. A significant sediment flux increase also occurred in March-April 2006 due to another intense cascading pulse. In this transport event, suspended sediment concentration only increased at 1000 m depth in the Cap de Creus Canyon and on the open slope, but not at the canyon head, suggesting a redistribution of sediments previously deposited at mid-canyon depths. Deeper than 1000 m, net fluxes show that most of the suspended sediment left the canyon and flowed along the southern open slope towards the Catalan margin, whereas a small part flowed downcanyon and was exported basinward through the canyon mouth. Additionally, the increase of the deep-sea near-bottom currents induced by open-sea convection processes, combined with the arrival of deep cascading pulses, also generated moderate but continuous suspended sediment transport at deeper slope regions.

References
1 - Palanques A., Durrieu de Madron X., Puig P., Fabres J., Guillén J., Calafat A., Canals M., Heussner S. and Bonnin, J., 2006. Suspended sediment fluxes and transport processes in the Gulf of Lions submarine canyons. The role of storms and dense water cascading. *Mar. Geol*., 234: 43-61.
2 - Heussner S., Durrieu de Madron X., Calafat A., Canals M., Carbonne J., Delsaut N. and Saragoni G., 2006. Spatial and temporal variability of downward particle fluxes on a continental slope: Lessons from an 8-yr experiment in the Gulf of Lions (NW Mediterranean). *Mar. Geol*., 234: 63-92.
3 - Canals M., Puig P., Heussner S., Durrieu de Madron X., Palanques A. and Fabres J., 2006. Flushing submarine canyons. *Nature*, 444: 354-357
4 - Palanques A., Puig P., Latasa M. and Scharek R., 2009. Deep sediment transport induced by storms and dense shelf-water cascading in the northwestern Mediterranean basin. *Deep-Sea Res*., 56: 425–434.
5 - Schott F., Visbecck M., Send U., Fisher J., Stramma L. and Dsaubies Y., 1996. Observations of deep convection in the Gulf of Lions, Northwestern Mediterranean during the winter of 1991/92. *J. Phys. Oceanogr*., 26: 505-524.

AIR-SEA HEAT FLUXES ESTIMATION IN THE AEGEAN SEA (EASTERN MEDITERRANEAN SEA)

V. P. Papadopoulos [1]*, T. G. Chronis [2], S. Ruiz [3], E. Tragou [4], S. Josey [5] and G. Feredinos [6]
[1] Hellenic Centre for Marine Research, Local Office of Achaia, Greece - vassilis@ath.hcmr.gr
[2] Hellenic Centre for Marine Research, Anavyssos Attiki, Greece
[3] IMEDEA (CSIC-UIB), Mallorca, Spain
[4] University of the Aegean, Dept. of Marine Sciences, Mitilini, Greece
[5] National Oceanography Centre, Southampton, UK
[6] University of Patras, Dept. Geology, Rion, Greece

Abstract

We present a merged technique for producing monthly mean air-sea heat fluxes values in the Aegean Sea from bulk formulae. The input variables are mainly drawn from the POSEIDON buoy network of the Hellenic Centre for Marine Research (HCMR). Time series derived from five buoys encompassing a period from January 2000 to December 2008 are used together with satellite data and coastal meteorological observations to estimate heat fluxes over the marine boundary layer. The estimated monthly mean values are further compared with widely used global gridded datasets.

Keywords: Air-Sea Interactions, Heat Budget, Aegean Sea

Air-sea heat fluxes are crucial for understanding the role of the oceanic environment in the climatic processes as a main driver of the global atmospheric and oceanic circulations. But they are not readily quantified and their basic input variables mostly come from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS, Voluntary Observing Ship program) since the buoy measurements are scarce and the satellites are still unable to provide accurately all the necessary variables [1, 2]. HCMR's Poseidon network consists of oceanographic buoys that monitor meteorological, sea state, upper ocean physical and biochemical data in a 3-hour time intervals [3]. The network is operational since late 1999 and provides four key variables needed for estimating the aforementioned heat fluxes. These are atmospheric pressure, air temperature, sea surface temperature and wind speed. Seasonal maintenance and sensors calibration ensures the network reliability. Cloud fraction is estimated based on 3-h observations provided by a number of coastal stations of Hellenic National Meteorological Service (Fig.1). Simultaneous cloudiness observations from 2-3 nearby stations are spatially interpolated to produce a composite cloud fraction at each buoy location.

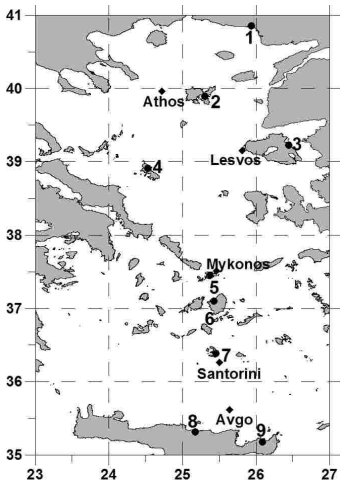


Fig. 1. Buoy sites and the 9 meteo stations over the Aegean Sea.

Additionally, the specific humidity is estimated from the SSM/I brightness temperatures (F13, F14 and F15 platforms; [4]). Over the study area an average of 5-6 overpasses were available on a daily basis (while F14 was operational). In order to achieve more representative values, the satellite brightness temperatures from all the daily swaths are selected within a radius of 0.5^o from the buoy site and are interpolated in time to be fitted in the 3-h interval dataset. The incoming solar shortwave radiation Q_s is calculated from the Reed bulk formula using the List formula for clear sky irradiance as more appropriate for the Mediterranean Sea conditions. A correction to the clear sky insolation due to the aerosol attenuation is applied according to Tragou and Lascaratos [5]. The net longwave radiation Q_b is computed using the most suitable for the Mediterranean, Bignami formula. For the turbulent components, latent heat Q_e and sensible heat Q_h, the state-of-the-art COARE v3.0 algorithm is used [8]. As a general rule, monthly mean values are estimated when less than 10% data are missing. The final products are further statistically compared against the following heat flux datasets: a) the National Oceanography Centre of Southampton air-sea interaction gridded dataset [1]; b) the OAFlux project dataset of WHOI [6]; and c) the HIPOCAS Mediterranean Sea high-resolution atmospheric dataset [7]. Due to large gaps in our dataset a statistical comparison over a whole year is not possible, therefore only concurrent measurements are involved. Table 1 illustrates results from the preceded statistical comparisons. The period of comparison is referred to 2000-2006 for NOC dataset, 2000-2007 for OAFlux and 2000-2001 for HIPOCAS. According to the main statistical features the most suitable gridded product is appeared to be the OAFlux dataset for all the components except the net longwave radiation for which the HIPOCAS dataset seems to fit better. The relatively large biases of NOC dataset are apparently attributed to the different bulk formulae for the clear sky insolation and for the net longwave radiation. Q_b from OAFlux dataset exhibits no correlation not only with the in situ data but also compared against the other two gridded products.

Tab. 1. Main statistics of the comparisons with the gridded datasets. N is the number of compared values.

Heat Fluxes Comp.	NOC				OAFLUX				HIPOCAS			
	N	bias	rmse	cc	N	bias	rmse	cc	N	bias	rmse	cc
Q_{net}	131	-66.5	91.0	0.93	131	-10.5	35.0	0.96	63	-19.3	40.6	0.95
Q_s	399	-25.0	35.9	0.97	459	-2.3	13.6	0.99	120	9.0	15.8	0.98
Q_b	131	-28.2	30.7	0.60	142	-12.2	19.5	0.08	63	-15.2	16.7	0.62
Q_e	131	-0.2	42.6	0.64	131	5.4	25.8	0.82	63	-8.3	32.2	0.76
Q_h	131	-9.5	17.4	0.85	131	-0.4	7.3	0.97	63	-8.0	13.6	0.93

References

1 - Berry D. and Kent E., 2009. A new air-sea interaction gridded dataset from ICOADS with uncertainty estimates. *B. Meteorol. Soc.*, 90, 5: 645-656.

2 - Yu L. and Weller R.A., 2007: Objectively analyzed air-sea heat fluxes for the global ice-free oceans (1981–2005). *B. Am. Meteorol. Soc.*, **88:** 527–539.

3 - Nittis K., Zervakis V., Perivoliotis L., Papadopoulos A. and Chronis G, 2001. Operational monitoring and forecasting in the Aegean Sea: System limitations and forecasting skill evaluation. *Mar. Pollut. Bull.*, 43: 154-163

4 - Bentamy A., Katsaros C., Mestas-Nunez A., Drennan W., Forde E. and Roquet H., 2003. Satellite estimates of wind speed and latent heat flux over the Global Oceans. *J. Climate*, 16: 637-656.

5 - Tragou E. and Lascaratos A., 2003. Role of aerosols on the Mediterranean solar radiation. *J. Geophys. Res.*, 108 (C2): 3025-3038.

6 - Yu L., Jin X. and Weller R.A., 2008: Multidecade Global Flux Datasets from the Objectively Analyzed Air-sea Fluxes (OAFlux) Project: Latent and sensible heat fluxes, ocean evaporation, and related surface meteorological variables. Woods Hole Oceanographic Institution, OAFlux Project Technical Report. OA-2008-01, 64pp. Woods Hole. Massachusetts.

7 - Ruiz S., Gomis D., Sotillo M. and Josey S., 2008. Characterization of surface heat fluxes in the Mediterranean Sea from a 44-year high-resolution atmospheric data set. *Global Planet. Change*, 63, 2-3: 258-274.

RECORD-BREAKING SEA LEVELS IN THE NORTHERN ADRIATIC ON 1 DECEMBER 2008

M. Pasaric [1]*, S. Cupic [2], N. Domijan [2], N. Leder [2] and M. Orlic [1]
[1] Hydrographic Institute of the Republic of Croatia, Split, Croatia
[2] Andrija Mohorovicic Geophysical Institute, Faculty of Science, University of Zagreb, Zagreb, Croatia - mpasaric@irb.hr

Abstract

Exceptionally strong storm surge that occurred on 1 December 2008, when record-breaking sea level was recorded in the Northern Adriatic, is analysed using sea-level data from tide gauges along the eastern Adriatic coast. The event was a result of fine tuning between the storm surge brought about by a series of synoptic atmospheric disturbances, the tide and the preexisting Adriatic basin-wide seiche, all superimposed on a significant sea level rise due to the low-frequency atmospheric disturbance related to planetary waves, whereupon the local seiche activity additionally increased the sea level.
Keywords: Adriatic Sea, Sea Level

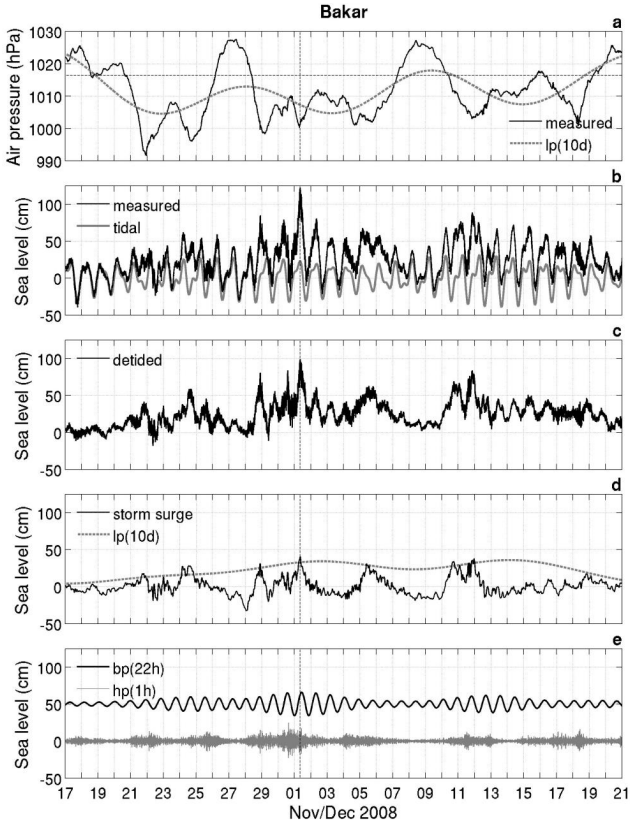


Fig. 1. The episode of exceptionally high sea level recorded at Bakar: (a) original air-pressure time series and the data low-pass filtered at 10 days; (b) the recorded time series of 1-minute sea-level data and the tidal prediction; (c) the sea level upon removal of the tidal signal; (d) the sea-level time series, low-pass filtered at 10 days and the storm-surge activity related to synoptic atmospheric disturbances; (e) sea level, band pass filtered around 22 hours, which corresponds to the principal mode of the Adriatic basin-wide seiche and high-pass filtered (at 1 hour) time series representing the local seiche activity.

During late autumn and winter the coastal area of the Northern Adriatic is occasionally exposed to extremely high sea level (*acqua alta*), which floods the towns and brings great damage to urban infrastructure. Venice is most vulnerable to this phenomenon, but other towns in the region are sometimes also severely affected. One exceptional occurrence took place on 1 December 2008. On this occasion not only the Northern Adriatic coast was flooded, but the sea level rose high above its usual values along the greater part of the Dalmatian coast north of Split. The towns of Trogir, Šibenik, Zadar, Rijeka and many other were flooded while in some harbors ships were damaged. At Bakar the sea level reached 121 cm which is absolutely the highest value recorded at the longest operating Croatian tide gauge in use since 1929, with a 10-year break around Second World War. Exceptionally high sea level was also registered on the Italian coast of the Adriatic. In Venice the sea level reached 156 cm [1], which is the fourth highest value since 1923.

The event was well documented by tide gauges of the Croatian network of permanent stations. The network was modernized in 2003 with digital instruments and GSM modems for the data transmission, thus providing real-time data and enabling the prompt and detailed analysis of the event. The peak event occurred at Bakar at 08:15 CET, with sea level reaching 121 cm; at Rovinj the highest instantaneous sea level (95 cm) was recorded at 11:36 CET, at Zadar the maximum (83 cm) occurred at 08:39 CET, at Split it was 71 cm at 07:02, while at Dubrovnik sea level maximum was considerably lower (50 cm). The beginning of the episode can be tracked two weeks before - a large-scale air-pressure disturbance, related to passage of planetary atmospheric waves, caused sea level to slowly rise (Figure 1) thus securing preconditions for the occurrence of extreme sea levels [2]. This intensified in the next days when a series of weather fronts passed over the Adriatic, each time triggering off the Adriatic seiche. Three days prior to the peak event a very strong sirocco started to blow, piling up water in the shallow Northern Adriatic. On the morning of 1 December 2008 yet another front passed over the Adriatic – the air pressure at Bakar reached its minimum value at 07:30 CET, just shortly before the tide reached its daily maximum and the preexisting Adriatic seiche was heading towards its maximum. Hence, when the tide reached its maximum at 08:15 CET sea level at Bakar went up to its highest level since the start of the uninterrupted measurements in 1949 and also likely since the start of the tide gauge 79 years ago. This record-breaking level was a result of fine tuning between the storm surge (~40 cm) brought about by a series of synoptic atmospheric disturbances, the tide (23 cm) and the preexisting Adriatic basin-wide seiche (13 cm), all superimposed on a 33 cm sea level rise due to low-frequency atmospheric disturbance related to planetary waves, whereupon the local seiche activity within the Bakar Bay contributed with additional 10 cm.

References

1 - Venice Municipality - Tide Monitoring and Forecast Center (http://www.comune.venezia.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/1748).
2 - Pasaric M. and Orlic M., 2001. Long-term meteorological preconditioning of the North Adriatic coastal floods. *Cont. Shelf Res.* 21: 263-278.

SURFACE CIRCULATION OF THE EASTERN MEDITERRANEAN BETWEEN NOVEMBER 2005 AND OCTOBER 2007 INFERRED FROM IN-SITU DRIFTER TRAJECTORIES, MODEL AND ALTIMETRY DATA.

R. Pennel [1]*, K. Béranger [1], V. Taillandier [2], J. M. Lellouche [3], R. Gerin [4], I. Taupier-Letage [5], S. Ben Ismail [6], P. M. Poulain [4] and C. Sammari [6]

[1] Ecole Nationale Supérieure de Techniques Avancées - Unité de Mécanique, Palaiseau, France - romain.pennel@ensta.fr

[2] Laboratoire d'Océanographie de Villefranche, Villefranche sur Mer, France

[3] Mercator Océan, Toulouse, France

[4] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy

[5] Laboratoire d'Océanographie Physique et Biogéochimique, La Seyne sur Mer, France

[6] Institut Nationale des Sciences et Techniques de la Mer, Salammbô, Tunisia

Abstract

We study the surface circulation of the Eastern Mediterranean basin over 2005-2007 by comparing drifter trajectories, models and altimetry. Using pseudo-Eulerian statistics, we investigate a way to validate the model or altimetry circulation schemes with drifter data measurements.

Keywords: Eastern Mediterranean, Circulation, Models

The surface circulation in the eastern Mediterranean Sea is investigated by means of surface tracked drifters, numerical models and altimetry data for the period spanning from November 2005 to October 2007.

Within the framework of the EGYPT/EGITTO program, a total of 97 drifters drogued at 15-m nominal depth were released between September 2005 and March 2007 in the Sicily Channel and the Ionian basin [1]. All drifters were tracked with the Argos Data Location and Collection System (CLS). Drifter positions have accuracy better than 1000m. After editing, the drifter position time series were linearly interpolated every 2 hours using the kriging technique, and were then low-pass filtered and subsampled every 6 hours. The velocities were computed by finite-centered differences [2]. It is important to note that, despite the hundredth of drifters and the 18 months duration, the resulting mean pattern remains highly constrained by the spatio-temporal distribution of the drifters, up to rendering artifacts due to mesoscale eddies [1].

The numerical simulations were carried out using the Mediterranean model MED16 [3, 4] and the extracted Mediterranean domain from the operational PSY2v2 forecasting system [5], regional configurations of the primitive-equation model Ocean Parallel [6]. The horizontal resolution of both models is 1/16°(5-7km) and there are 43 vertical levels. The models were forced by daily air-sea flux and wind fields from the analyses of the European Centre of Medium-range Weather Forecast (ECMWF).

The altimetric data available for this study from CLS are the geostrophic velocities deduced from Sea Level Anomaly maps. Data are interpolated over a regular 1/8°x1/8° grid, every 7 days [7].

Both modeled and altimetric data are low-pass filtered and interpolated in space and time at the drifter positions following the method of [2]. On a grid with 0.25°x0.25° mesh, pseudo-Eulerian statistics are computed (mean current, variance ellipses, mean and eddy kinetic energies).

For example, mean flow and kinetic energy are shown for in situ observations and MED16 (Fig 1). On one hand, some of the main features of the mean flow agree, for both model and drifters : i) the main flow of Atlantic Waters (AW) bifurcates, upon exiting the Sicily Channel, into a northern branch and a southeastward one; ii) the southeastward branch reaches Libya West of 20°E and iii) from ~24°E , the eastward coastal current along Africa associated with mesoscale eddies in agreement with [8], continues northward along the Middle-East slope.

On the other hand, model and drifters mean kinetic energies mostly disagree in several areas. For example, offshore between 24°E-31°E, both mean flows show complex patterns, mostly opposite between 24 and 27°E, even displaying a partial eastward flow. This is related to a strong signature of mesoscale patterns (mostly eddies like Ierapetra or Lybian eddies at this place) in the in situ data. Actually, a good agreement between these datasets requires an exact spatio-temporal correlation between the positions of the observed and modelled eddies.

In a next step, using the whole spatio-temporal sampling of the models, we will check whether this scheme is still relevant for validating the models.

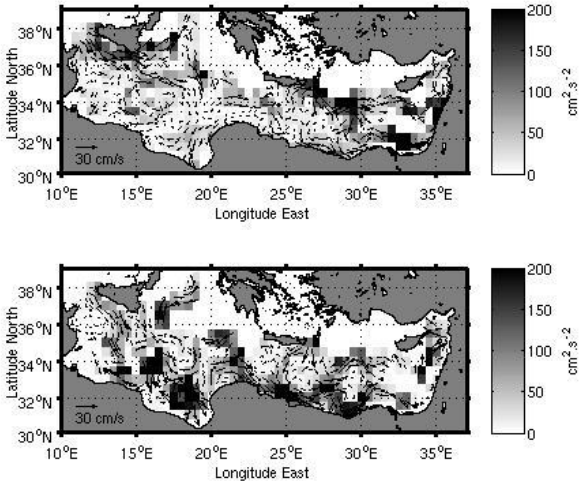


Fig. 1. Mean flow superimposed on Mean Kinetic Energy using kriged drifters data (top) and MED16 model (bottom)

References

1 - Gerin R., Poulain P.-M., Taupier-Letage I., Millot C., Ben Ismail S. and Sammari C., 2009. Surface circulation in the Eastern Mediterranean using drifters (2005-2007). *Ocean Sci.*, 5: 559–574.

2 - Poulain P.-M. and Zambianchi E., 2007. Surface circulation in the central Mediterranean Sea as deduced from Lagrangian drifters in the 1990s. *Cont. Shelf Res.*, 27: 981-1001.

3 - Alhammoud B., Béranger K., Mortier L., Crépon M. and Dekeyser I., 2005. Surface circulation of the Levantine Basin : comparison of model results with observations. *Prog. Oceanogr.*, 66: 299-320.

4 - Béranger K., Mortier L. and Crépon M., 2005. Seasonal variability of water transport through the straits of Gibraltar, Sicily and Corsica, derived from a high-resolution model of the Mediterranean circulation. *Prog. Oceanogr.*, 66: 341-364.

5 - Lellouche J.-M., Greiner E. and Benkiran M., 2005. PSY2v2, le nouveau prototype opérationnel haute résolution de Mercator. Mercator Océan quarterly newsletter, 19, www.mercator-ocean.fr/documents/lettre/lettre_19.pdf.

6 - Madec G., Delecluse P., Imbard M. and Lévy C., 1998. OPA 8.1 ocean general circulation model reference manual. Notes du pôle de modélisation IPSL.

7 - Pujol M.-I. and Larnicol G., 2005. Mediterranean sea eddy kinetic energy variability from 11 years of altimetric data. *J. Marine Syst.*, 58: 21-142.

8 - Hamad N., Millot C. and Taupier-Letage I., 2005. A new hypothesis about the surface circulation in the eastern basin of the mediterranean sea. *Prog. Oceanogr.*, 66: 287-298.

OBSERVATION OF UPPER LAYER INERTIAL AND INTERNAL WAVES IN THE CENTRAL LIGURIAN SEA

P. Picco [1], S. Pensieri [2], A. Cappelletti [3], R. Bozzano [2], E. Schiano [4]* and S. Sparnocchia [5]

[1] Consiglio Nazionale delle Ricerche - Istituto di Scienze Marine, Via de Marini 6, 16149 Genova, Italy - elisabetta.schiano@ismar.cnr.it

[2] Ente per le Nuove Tecnologie, l'Energia e l'Ambiente, Centro Ricerche Ambiente Marino, forte Santa Teresa , Pozzuolo di Lerici (SP), Italy

[3] Ente per le Nuove Tecnologie, l'Energia e l'Ambiente, Via V.Viaviani 23, 56124, Pisa , Italy

[4] Consiglio Nazionale delle Ricerche-Istituto di Studi sui Sistemi Intelligenti per l'Automazione, via de amrini 6, 16149, Genova, Italy

[5] Consiglio Nazionale delle Ricerche - Istituto di Scienze Marine, Viale R. Gessi 2, 34123 Trieste, Italy

Abstract

Inertial and internal waves in the Central Ligurian Sea are investigated by using long time series of high frequency observations of both ADCP currents and temperature profiles in the upper thermocline. Horizontal variability is dominated by the inertial currents which have a kinetic energy comparable with that of the mean currents. Time frequency analysis evidences the presence of internal waves having periods in the sub-daily band, between 6 and 17 h (the local inertial period). During summer, these vertical oscillations may affect the temperature time series at a fix depth up to several degrees.

Keywords: Air-Sea Interactions, Currents, Ligurian Sea, Time Series, Temperature

Data and methods

In order to investigate the variability of the upper layer, a mooring equipped with an upward-looking ADCP (Acoustic Doppler Current Profiler) RD&I Sentinel 300 kHz and CTD sensors was deployed in the open Ligurian Sea (43° 47.77' N; 9°02.85 E) near the meteo-oceanographic buoy ODAS Italia1. The ADCP sampled the upper 50 m of water column from 13 September, 2003 to 25 May 2004 and from September 2004 to June 2006 thus providing a long-term time series of 3-D currents data. Meteorological parameters, in particular wind speed and direction and atmospheric pressure, were measured each hour from the buoy ODAS at 13.5 m above the sea surface until 11 March 2004. Sea temperature and conductivity at six different depths, between surface and 36 m, were also collected each hour from the buoy. Spectral analysis and the methodology proposed by Jacobs et al. [1] were used to evidence the time-spectral characteristics of the observed oscillations.

Results

The upper layer currents variability in the investigated area is mainly due to the inertial currents. They occur very often, can persist several days and have a kinetic energy comparable with that of the mean currents. The more energetic ones are found at the end of the summer, when the thermocline is still well developed, while during winter their amplitude is reduced. Inertial oscillations are very common in the ocean. They can be locally generated at the sea surface by changes in wind stress or by the rapid transit of a low and can persist for several days. These oscillations propagate energy far from the area of generation as well as downward in the water column, generating higher-frequency internal waves through non linear interactions [2]. For their contribution to the mixing, they are of particular importance in regions such as the Ligurian Sea, since they compensate the lack of the tidal mixing. No clear relation between local wind stress and the onset of horizontal inertial currents was found in this analysis. The existence of mixed layer inertial currents unrelated to wind forcing is reported by different authors. Van Haren and Millot [3] found similar results in the Ligurian Sea and gave evidence to the important role of the thermal stratification of waters in the vertical propagation. The time series of the vertical currents clearly show the occurrence of intermittent burst of oscillations reaching the amplitude of few centimeters per second. The signal was present in the entire sampled water column, but the amplitude attenuated with increasing depth. The time-frequency analysis confirms that these oscillations develop both in summer and in winter, even the episodes last only a few days. Their frequency varies in the sub-daily band, spanning from few cycles per day to the local inertial frequency (local inertial period is 17.3 h). Differently from the horizontal inertial currents, the comparison with available local wind time series evidenced a nearly one-to-one correspondence between the wind stress relative maximum and the occurrence of vertical currents oscillations, identified by a maximum of daily standard deviation, but at a first analysis their amplitude doesn't seem relate to the intensity of wind stress. Bursts of oscillation in the sub-daily band are detected also in the temperature time series in the upper thermocline. During summer months, when the thermal stratification reaches its maximum, the temperature variation at 35 m due to the internal waves reached more than 4 °C.

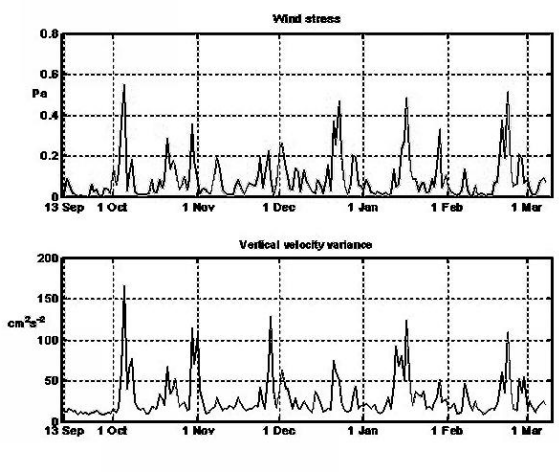


Fig. 1. Time series of daily mean wind stress magnitude and vertical velocities standard deviation.

References

1 - Jacobs G. A., Book J.W., Perkins H.T. and Teague W.J., 2001. Inertial oscillations in the Korea Strait, *J. Geophys. Res.* 106, (C11): 26943-26957.

2 - Plueddemann A.J. and Farrar J.T., 2006. Observations and models of the energy flux from the wind to mixed-layer inertial currents. *Deep-Sea Res. II*, 53: 5-30.

3 - Van Haren H. and Millot C., 2003. Seasonality of internal gravity waves kinetic energy spectra in the Ligurian Basin. *Oceanol. Acta*, 26: 635-644.

A LATENT-CLASS APPROACH TO MISSING VALUE IMPUTATION IN INCOMPLETE MULTIVARIATE WAVE METRIC DATASETS

Marco Picone [1]*, Francesco Lagona [1], Gabriele Nardone [2] and Mauro Bencivenga [2]
[1] GRASPA and DIPES - University Roma Tre, Rome, Italy - marcopic83@libero.it
[2] ISPRA - Marine Service, Rome, Italy

Abstract
We propose a latent-class model where the joint distribution of linear and circular data is specified through a finite mixture of conditionally independent Gamma and von Mises distributions. Missing values are imputed by drawing multiple imputations from the predictive distribution of the missing values given the observed data, at the maximum likelihood estimates. The procedure is illustrated on an incomplete dataset that includes measurements of wind speed and direction and significant wave height and direction, taken by a buoy and two tide gauges of the Italian wave-metric network.
Keywords: Waves, Wind/Font, Sicilian Channel

Environmental multivariate data are disseminated by environmental protection agencies for a variety of purposes, including the estimation of statistical models that detect significant relationships between different environmental measurements. Incomplete datasets, where some of the measurements are missing, pose a serious obstacle in the fulfillment of these purposes. There is an extensive literature about the estimation of statistical models in the presence of missing values. However, these methods often require the expertise of a trained statistician, as they involve both computational and methodological issues that can be challenging, depending on the nature of the mechanism that generate the missing values and the complexity of the model that is exploited for analysis. To reduce the workload of the data analyst, incomplete data should be provided in a way that they can be analyzed by "standard" methods, i.e. methods that require the availability of complete data information. Environmental data could be completed by imputing missing values according to an imputation model. This approach is referred to as single imputation. It is however well known that if the data analyst uses complete-data methods for analyzing the completed dataset by treating imputed values as if they were real data, this generally leads to variance estimates that are too low, confidence intervals which are too narrow, and wrong tests (real significance level above nominal level).

Multiple imputation (MI [1]) has been suggested as a way of overcoming the variance estimation problem that arises under a single-imputation strategy. Under a MI protocol, the data-base constructor (or imputer) and the end user (or data analyst) are thought as distinct entities. The data-base constructor draws a number of imputed values from the predictive distribution of the missing values, given the observed data, computed on the basis of an imputation model. The resulting completed datasets are appended together to provide an augmented dataset to the data analyst, who can exploit standard methods to simultaneously examine these datasets and, appropriately pooling the results, use them to correct for the variability in the imputations, which differs from the variability in the observed data. Directions about the pooling procedure are provided by the imputer and involve simple calculations, which can be carried out by a data-analyst who is not necessarily a trained statistician. Under a MI strategy, imputation is typically carried out by estimating a parametric model from the complete cases and using the predictive distribution of the missing data given the observed data to draw a number of imputations for each missing value in the incomplete dataset. Under a frequentist approach, the imputation model is estimated by maximum likelihood and imputations are drawn from the conditional distribution of the missing values, given the observed data, evaluated at the maximum likelihood estimate of the parameters that have been obtained from the observed data.

Latent-class, mixture models have been proposed as flexible imputation models when incomplete datasets include categorical [2] or mixed categorical and continuos variables [3]. We extend this approach to the case of linear-circular variables, by specifying a multivariate mixture of Gamma and von Mises distributions. The model clusters incomplete data into homogenous groups and exploits this classification to complete records with missing values. Parameters of the mixture model are estimated by maximization of the likelihood from the observed data, by a suitable E-M algorithm that allows for missing values. Imputations are then drawn from the multivariate conditional distribution of the missing values given the observed data, evaluated at the maximum likelihood estimate. We evaluate the performance of this imputation method by means of predictive intervals and nonparametric cross-validation.

Results of the MI procedure are illustrated on an incomplete dataset that includes hourly measurements of wave height and direction, taken in the period 10/13-11/11/2003 by the buoy of Mazzara del Vallo located at about 10 Km from the southern coast of Sicily. The dataset also includes eight-hours moving averages of wind speed and direction, taken from the two nearest tidal stations, respectively located at Porto Empedocle (Sicilian coast, about 100 Km from the buoy) and at Lampedusa Island (about 250 Km from the buoy).

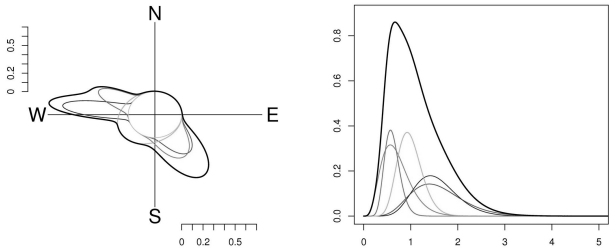


Fig. 1. The 5-components mixture distribution of wave direction (left) and height (right), as estimated by a latent-class multivariate model

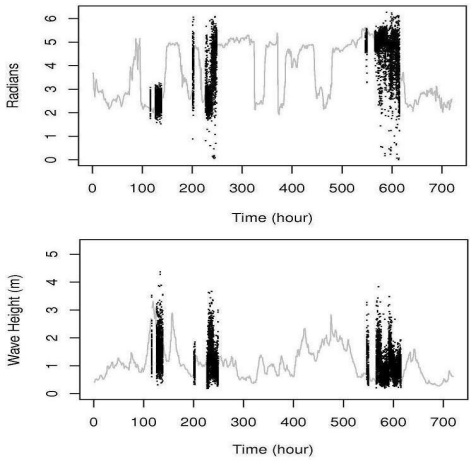


Fig. 2. Imputed values (dots) and observed data (grey line) of wave direction (top) and height (bottom), yielded by a 5-components latent-class model

References
1 - Rubin DB., 1987. Multiple Imputation for Nonresponse in Surveys. New York, John Wiley.
2 - Vermunt JK, Van Ginkel JR, Van der Ark LA, Sijtsma K., 2008. Multiple imputation of categorical data using latent class analysis, *Sociological Methodology*, 33: 369-297.
3 - Hunt L. and Jorgensen, M., 2003. Mixture model clustering for mixed data with missing information, *Comput. Stat. Data Anal.*: 41: 429-440.

FROM OCEAN MESOSCALE MODELLING TO OPERATIONAL OCEANOGRAPHY: A TRIBUTE TO A.R. ROBINSON

Nadia Pinardi [1]*

[1] CIRSA, University of Bologna, Bologna, Italy - n.pinardi@sincem.unibo.it

Abstract

A.R. Robinson was the pioneer of ocean mesoscale modelling and data assimilation. His extraordinary knowledge about ocean mesoscale processes, advanced technologies for monitoring and numerical modelling made it possible for operational oceanography to emerge as a new science in support of the sustainable development of all marine activities.

Keywords: Circulation Models, Mesoscale Phenomena, Eastern Mediterranean

A.R. Robinson (1932-2009) was the founder of ocean forecasting, starting from mesoscale modelling up to the development of the general methods for ocean forecasting. He defined the three methodological phases for forecasting mesoscale eddies in the ocean and carried out the experiments at sea and with numerical models to demonstrate the effectiveness of the methodology [1].

Starting with the MODE and POLYMODE experiments in the 70's, he showed that the ocean was dominated by mesoscale eddies 4-5 times the Rossby deformation radius and that the energy and vorticity processes of this flow field are characterised by frontal dynamics and baroclinic instabilities [2]. In 1983 he designed and carried out the first 'Real Time Forecasting Experiment' in the California Current [3]. In the figure the principle of ocean forecasting is summarized: collect synoptic data and produce an initial condition as accurate as possible to control the error growth by intense nonlinearities in the ocean [4].

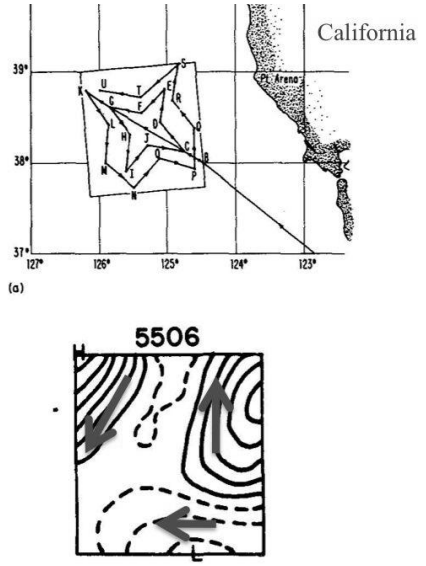


Fig. 1. The essential components of the first real time forecasting experiment carried out by Robinson and collaborators in the California current in 1983 [3, 4]. The top of the picture shows the sampling pattern in a 150 x 150 kmsq region which was repeated three times giving rise to data that allowed to calculate the geostrophic streamfunction shown in the panel below. The direction of currents is shown by red arrows overlaid on the pictures.

Robinson devised the in situ data collection sampling methods and the modelling tools at the same time, capable to forecast nonlinear ocean mesoscale eddies up to few weeks in the future. His contribution to ocean forecasting was even more important for the seminal work carried out at the beginning of the eighties in understading and demonstrating the usage of Geosat altimeter data for ocean forecast initailization, a crucial step for operational oceanography [5].

At the same time he was thinking to demonstrate that forecasting was possible in the Gulf Stream area, a region extremely non-linear and ageostrophic so that, if forecast would be successful, it would demonstrate that ocean forecasting is possible everywhere in the world ocean. Again he invented a method to overcome the scarcity of data in this region: the feature model initializion method that combines the oceanographic knowledge of the processes and structures of the region with observations that are gappy and unfrequent. The first successful forecast of Gulf Stream evolution and ring detachment was then carried out in 1984 [6].

Meantime all these developments were undergoing in the Atlantic and Pacific ocean he turned his attention to the Mediterranean Sea, preparing the ground for the modern and scientifically based evidence of the large scale general circulation of the Eastern Mediterranean Sea. He was the father of the 'Physical Oceanography of the Eastern Mediterranean-POEM' program that lasted ten years and collected the first intercalibrated basin scale data sets at 0.5 degree resolution for the entire eastern basin. His description of the general flow field of the Eastern Mediterranean is a benchmark of our understanding of the Mediterranean Sea circulation. It shows new structures and phenomena, the sub-basin scale gyres instabilities, new eddy-gyres structures never revealed before, recurrent eddies phenomena not yet fully understood. His work pointed out the intense eddy dynamics of the South-Eastern Levantine area [7], the presence of anticyclonic gyres that merge and enlarge, depicting the intense quasigeostrophic turbulent cascade processes of this area [8]. After this phase, as part of a general methodology for starting ocean forecasting activities in the world ocean, he dedicated a major effort to implement ocean forecasting in the Sicily Strait and Ionian Sea, describing the dynamics of these areas at unprecedented resolution and demonstrating the quality of forecasting [9] .

References

1 - Robinson A.R and Leslie W.G., 1985. Estimation and Prediction of Oceanic Fields. *Prog. Oceanogr.*, 14: 485-510

2 - Robinson A.R. (ed.), 1983. Eddies in marine Sciences, Springer-Verlag, New York/Heidelberg, 609 pp

3 - Robinson A.R., Carton J.A., Mooers C.N.K., Walstad L.J., Carter E.F., Rienecker M.M., Smith J.A. and Leslie W.G., 1984. A Real-Time Dynamical Forecast of Ocean Synoptic/Mesoscale Eddies. *Nature*, 309(5971): 781-783.

4 - Robinson A.R., Carton J.A., Pinardi N. and Mooers C.N.K., 1986. Dynamical Forecasting and Dynamical Interpolation: An Experiment in the California Current. *J. Phys. Oceanogr.*, 16: 1561-1579.

5 - DeMey, P. and Robinson A.R., 1987.Assimilation of altimeter eddy fields in a Limited Area Quasigeostrphic Model, *J. Phys. Oceanogr.*, 17(12): 2280-2293

6 - Robinson A.R., Spall M.A. and Pinardi N., 1988. Gulf stream simulation and the dynamics of ring and meander processes. *J. Phys. Oceanogr.*, 18(12): 1811-1853.

7 - Robinson, A.R., Hecht A., Pinardi N., Bishop J., Leslie W.G., Rosentraub Y., Mariano A.J. and Brenner S., 1987. Small Synoptic/Mesoscale Eddies: the energetic variability of the Eastern Levantine Basin, *Nature*, 327(6118): 131-134

8 - Robinson A.R., Malanotte-Rizzoli P., Hecht A., Michelato A., Roether W., Theocharis A., Unluata U., Pinardi N. and the POEM Group, 1992. General Circulation of the Eastern Mediterranean, *Earth-Sci. Rev.*, 32: 285-309.

9 - Robinson A.R. and Sellshopp J., 2002. Rapid assessment of the coastal ocean environment. *In*: N.Pinardi and J.D.Woods (ed.), Ocean Forecasting: Conceptual basis and Applications, Springer-Verlag, 203-232.

A LAGRANGIAN VIEW OF THE EASTERN MEDITERRANEAN SURFACE CIRCULATION OVER THE LAST TWO DECADES

P. Poulain [1]*, R. Gerin [1], M. Menna [1], I. Taupier-Letage [2], C. Millot [2], S. Ben Ismail [3], C. Sammari [3], G. Zodiatis [4] and I. Gertman [5]
[1] Istituto Nazionale di Oceanografia e Geofisica Sperimentale, Trieste, Italy - ppoulain@inogs.it
[2] Laboratoire d'Océanographie Physique et de Biogéochimie, La Seyne, France
[3] Institut National des Sciences et Technologies de la Mer, Salammbo, Tunisia
[4] University of Cyprus, Nicosia, Cyprus
[5] Israel Oceanographic and Limnological Research, Haifa, Israel

Abstract
The surface circulation of the Eastern Mediterranean (EM) is studied using drifter data between 1990 and 2009, with particular attention to the Sicily Channel, and the Ionian and Levantine Seas. The drifter trajectories and the pseudo-Eulerian statistics computed from them (maps of mean circulation and eddy variability) reveal strong quasi-permanent surface currents over the continental slopes and in several anticyclonic gyres. Seasonal and interannual variability of the surface currents is mostly evident in the Sicily Channel and Ionian Sea.
Keywords: Circulation, Eastern Mediterranean

Surface drifters of various designs have been operated in the EM since 1990 as part of operational (military) and research programs to monitor the surface currents and the sea surface temperature. The most common drifter designs are the SVP and the CODE systems for which the water following characteristics are good and quantified [1]. All drifters were located by, and transmitted data to, the satellite Argos system. Recent models were also fitted with GPS receivers to increase the position accuracy and sampling frequency. The drifter data were processed and arranged in web-based databases under the MedSVP program. In particular, the data used in this work were interpolated (kriging) and low-pass filtered to exclude tidal and inertial motions. They were provided by a total of 487 drifters spanning the period January 1990 to November 2009 and amounting to a total of about 91 drifteryears. The drifter data (Figure 1) show the Atlantic Water (AW) entering in the Sicily Channel in two preferential paths, one close to the Tunisian coast (the Atlantic Tunisian Current), the other one located in the central and northern portion of the region, corresponding to the Atlantic Ionian Stream (AIS) [2, 3]. The surface currents are notably influenced by the wind forcing, with enhanced AW flow into the EM during NW Mistral winds prevailing in winter. This seasonality mainly driven by the winds is also evident in the southwestern Ionian [3]. In the northern Ionian, the drifters indicate both seasonal and interannual variabitlities with (1) a mean anticyclonic circulation dominating prior to mid-1997 and extending the AIS towards the NE [4]; (2) a general cyclonic circulation between mid-1997 and 1999, with the southern limb of the cyclone advecting AW towards the E in the central Ionian, and (3) alternating anticyclonic (cyclonic) circulation patterns in summer (winter) in 2006-2007 [3].

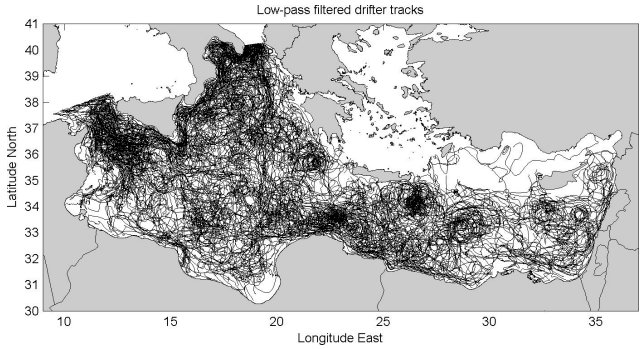


Fig. 1. Composite diagram of all the low-pass filtered drifter trajectories in the EM (excluding the Adriatic and Aegean Seas) between January 1990 and November 2009.

East of 20°E, the eastward motion of AW takes places in the Libyo-Egyptian Current (LEC) on the African continental slope and in the form of numerous anticyclonic eddies created by the instability of the LEC (Libyo-Egyptian Eddies, LEEs [3]), by the wind curl (Ierapetra and Pelops Eddies) and by topography. The northern limbs of some of these eddies in the open sea correspond to the Mid Mediterranean Jet put forward by the Physical Oceanography of the Eastern Mediterranean (POEM) project [5]. In the eastern Levantine Sea, the Lagrangian data reveals a strong coastal/slope northward current off the Middle East coast [3] along with several eddies presumably created by the instability of the coastal current. In particular, recent measurements in 2009 has confirmed the complexity of the surface circulation in this region and the persistence of strong eddies between Cyprus and Israel. In the northern Levantine, including the Cilician sub-basin, the drifter data are too scarce to deduct robust and significative results on the surface circulation. Pseudo-Eulerian statistics [2, 3] confirm the above results and provide a more quantitative description of the EM surface currents in terms of mean flow (Figure 2), eddy, seasonal and wind-induced variabilities. Kinetic energy levels of the mean (MKE) and fluctuating (EKE) components of velocity are high in the major currents and eddies mentioned above, and in general the EKE tend to exceed the MKE, indicating the predominance of the fluctuations with respect to the mean.

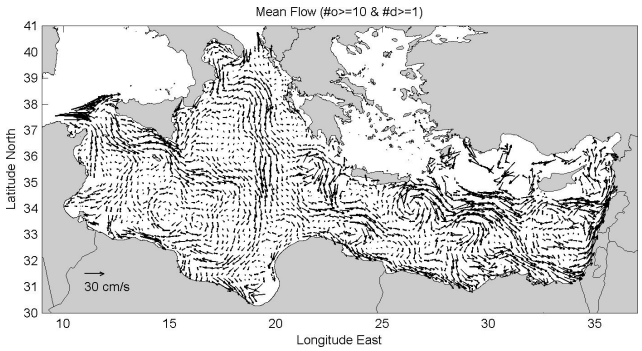


Fig. 2. Mean surface circulation of the EM based on the drifter data shown in Figure 1 averaged in bins of 0.25° x 0.25°.

References
1 - Poulain P.-M., Gerin R., Mauri E. and Pennel R., 2009. Wind Effects on Drogued and Undrogued Drifters in the Eastern Mediterranean. *J. Atmos. Ocean. Technol.*, 26: 1144-1156.
2 - Poulain P.-M. and Zambianchi E., 2007. Surface circulation in the central Mediterranean Sea as deduced from Lagrangian drifters in the 1990s. *Cont. Shelf Res.*, 27 (7): 981-1001.
3 - Gerin R., Poulain P.-M., Taupier-Letage I., Millot,C., Ben Ismail S. and Sammari C., 2009. Surface circulation in the Eastern Mediterranean using drifters (2005-2007). *Ocean Sci.*, 5: 559–574.
4 - Poulain P.-M., 1998. Lagrangian measurements of surface circulation in the Adriatic and Ionian Seas between November 1994 and March 1997, *Rapp. Comm. Int. Mer Medit.*, 35: 190-191.
5 - Robinson A. R., Golnaraghi M., Lesile W.G., Artegiani A. Hecht A., Lazzoni E., Michelato A., Sansone E., Theocharis A. and Unluata U., 1991. The Eastern Mediterranean general circulation: features, structure and variability. *Dyn. Atm. Oceans*, 15: 215-240.

THICK BOTTOM NEPHELOID LAYERS IN THE WESTERN MEDITERRANEAN BASIN GENERATED BY DENSE SHELF WATER CASCADING

P. Puig [1]*, X. Durrieu De Madron [2], K. Schroeder [3], J. Salat [1], J. L. López-Jurado [4], G. P. Gasparini [3], A. Palanques [1], M. Emelianov [1], A. P. Karageorgis [5] and A. Theocharis [5]

[1] Institut de Ciències del Mar, CSIC, Barcelona, Spain - ppuig@icm.csic.es

[2] Centre de Formation et de Recherche sur l'Environnement Marin, CNRS-Université de Perpignan, Perpignan, France

[3] CNR-ISMAR Pozzuolo di Lerici. La Spezia, Italy

[4] Instituto Español de Oceanografía (IEO), Palma de Mallorca, Spain

[5] Hellenic Centre for Marine Research, Institute of Oceanography. Athens, Greece

Abstract

The analysis of a compilation of deep CTD cast conducted in the western Mediterranean from 1998 to 2009 have documented the role that dense shelf water cascading off the Gulf of Lions plays in transporting suspended particulate matter from the coastal regions down to the basin. Deep CTD casts revealed that after the 1999 and 2005-2006 major cascading events the Western Mediterranean Deep Water was characterized by the presence of a thick bottom nepheloid layer that scaled in thickness with a thermo-haline anomaly generated by the mixture of dense waters formed by deep convection at open sea and by cascading off the Gulf of Lions shelf. The aim of this contribution is to characterize the observed bottom nepheloid layers and determine their spreading and residence time in the western Mediterranean basin.

Keywords: Western Mediterranean, Hydrography, Sediment Transport, Gulf Of Lions

Suspended particulate matter in the oceans plays a key role as extractors from, transporters through and sources to the water column of many major and minor elements, being responsible for maintaining most oceanic chemical concentration gradients [1, 2]. Particles are introduced into the ocean by biological production, rivers, glaciers, wind and bottom sediments resuspension. Biological, chemical and gravitational influences then act to remove particles from the water column. These removal processes, however, occur on much shorter time scales than the formation, movement or mixing of oceanic water masses. Particles, therefore, do not act as pure conservative tracers of water masses. However, their presence and concentration can indicate the location and intensity of oceanographic processes, particularly those involving the resuspension of sediments in deep-sea environments due to strong bottom currents, and be used as a tracer of water motions [3, 4].

The northwestern Mediterranean is one of the regions of the world where massive open sea dense water formation occurs because of cooling and evaporation of surface waters during winter-time [5]. Concurrent with this oceanographic process, coastal surface waters over the wide shelf of the Gulf of Lions also become denser than the underlying waters and cascade downslope, usually through submarine canyons, until reaching their equilibrium depth [6].

Dense shelf water cascading (DSWC) can last for several weeks and the associated strong currents can induce erosion and resuspension of surface sediments in the outer shelf/upper slope [7, 8] and, therefore, generate bottom nepheloid layers (i.e. layers of water that contains significant amounts of suspended sediment). Such layers can be detached at intermediate levels when the density of the mixture of water and particles reach their neutral buoyancy depth. In very dry, windy and cold winters, such as in 1999, 2005 and 2006, DSWC off the Gulf of Lions was exceptionally intense and reached depths >2000 m, evolving into a thick bottom nepheloid layer that spread along the lower continental slope and across the basin (Fig. 1).

The observed bottom nepheloid layers scaled in thickness with the thermo-haline anomaly generated by the mixture of DSWC and dense waters formed by deep convection at open sea, the later only bringing "blue water" free of particles to the basin, being up to 650 and 1450 m thick after the1999 and 2005-2006 events, respectively. Concentrations within the bottom nepheloid layer in the central part of the basin were usually around 0.3 mg/l (i.e. 0.1 mg/l above background levels), reaching higher concentrations close to the continental rise, with near-bottom peaks up to 2 mg/l. These bottom nepheloid layers could be observed to progress from the Gulf of Lions and Catalan margin towards the central part of the northwestern Mediterranean basin, reaching south of the Balearic Islands and west of Sardinia after the 1999 event, and covering the entire basin after the 2005 and 2006 events. Thickness and concentration of the bottom nepheloid layer diminished with distance away from their source and also with time. The turbidity signal could be barely distinguished one year after the 1999 event, but the one generated after the 2005-2006 events can be still clearly detected, confirming that fine particles in dilute nepheloid layers can have residence times of several years [3].

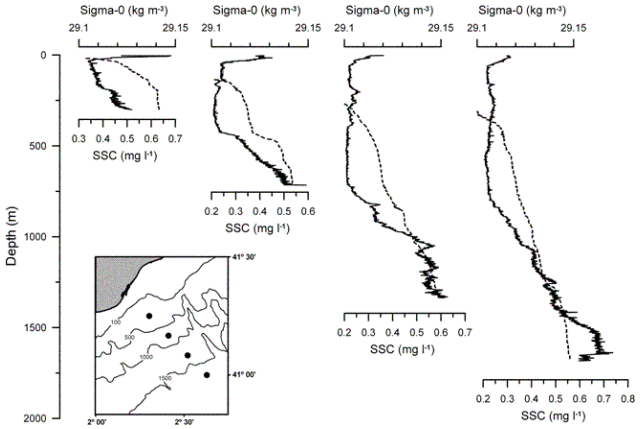


Fig. 1. Vertical profiles of suspended sediment concentration (SSC) and σθ from a hydrographical transect conducted across the Barcelona continental margin, from 300 down to 1700 m depth on 24 March 2005. The inset map shows the detailed location of the CTD casts.

References

1 - Biscaye P.E. and Eittreim S.L., 1977. Suspended particulate loads and transports in the nepheloid layer of the abyssal Atlantic Ocean. *Mar. Geol*., 23: 155-172.

2 - Eisma, D., 1993. *Suspended matter in the Aquatic Environment*. Springer-Verlag, Berlin, 315 pp.

3 - McCave I.N, 1986. Local and global aspects of the bottom nepheloid layers in the world ocean. Netherlands *Journal of Sea Research*, 20: 167-181.

4 - Gardner W.D., Richardson M.J. Walsh, I.D. and Berglund, B.L., 1990. In-situ optical sensing of particles for determination of ocean processes: processes: what satellites can't see, but transmissometers can. *Oceanography*, 3: 11-17.

5 - MEDOC group, 1970. Observation of formation of deep water in the Mediterranean Sea, 1969. *Nature*, 227: 1037-1040.

6 - Durrieu de Madron X., Zervakis V., Theocharis A. and Georgopoulos D., 2005. Comments on "Cascades of dense water around the world ocean". *Prog. Oceanogr*., 64: 83-90.

7 - Canals M., Puig P., Heussner S., Durrieu de Madron X., Palanques A. and Fabres J., 2006. Flushing submarine canyons. *Nature*, 444: 354-357.

8 - Puig P., Palanques A., Orange D.L., Lastras G. and Canals M., 2008. Dense shelf water cascades and sedimentary furrow formation in the Cap de Creus Canyon, northwestern Mediterranean Sea. *Cont. Shelf Res.*, 28: 2017-2030.

ESONET-EMSO DEEP SEAS OBSERVATORIES IN EUROPE: TOWARDS A COMMON INFRASTRUCTURE

Ingrid Puillat [1]* and Roland Person [1]
[1] IFREMER BREST, Département Géosciences Marines, 29280, Plouzané, France - ingrid.puillat@ifremer.fr

Abstract
ESONET is a Network of Excellence launched in March 2007 for 4 years (2007-2011) and coordinated by IFREMER. It involves 14 European countries, more than 50 institutions and SMEs, about 300 scientists, engineers and technicians. The network prepares the technical specifications to implement a permanent observatory infrastructure in the deep ocean around Europe with the ability to monitor a large range of physical, chemical and biological parameters. Amongst eleven key areas around Europe, four of them, located in the Mediterranean zone will be presented. An overview of the possible infrastructure at European scale will be presented. The conclusions will explain how this European observatory initiative is well integrated in a world wide "Deep sea observatory wave".
Keywords: Open Sea, Sampling Methods

European Seas Observatory NETwork (ESONET, http://www.esonet-emso.org) is a Network of Excellence (NoE) launched in March 2007 for 4 years (2007-2011) and coordinated by IFREMER (France). ESONET involves 14 European countries, more than 50 institutions and SMEs, about 300 scientists, engineers and technicians. Its budget is around 70 M€ as total cost, with a EU grant of 7 M€.

The ESONET network prepares the technical specification to implement a permanent observatory infrastructure in the deep ocean around Europe with the ability to monitor a large range of physical, chemical and biological parameters and to constitute a part of the marine branch of the global monitoring system of the Earth. The ESONET observatories will provide information on global change, warnings of natural hazards and a basis for sustainable management of the European Seas. The NoE unifies the communities and prepares the technical specifications of the seafloor and water column infrastructure that will be implemented by the European infrastructure project EMSO (coordinated by INGV). The NoE manages some common activities programs of members organisations and the main part of the work is driven in the framework of observatories Demonstration missions. Amongst networked tasks the most important ones are:

- the establishment and the recognition of involved international groups per site to prepare the implementation of Regional Legal Entities on the nodes of the infrastructure (EMSO PP project),
- to update the scientific objectives relevant to deep sea observatories at the top research level ([1]),
- the preparation of standardisation issues: sensor interface, sensor registry, data management for instance ([2]).
- to build a general business plan to be updated according each ESONET node and to prepare the implementation strategy,
- education, outreach and communication, for users, scientists, stakeholders, students, customers.

Eleven key areas around Europe have been identified as specific targets selected for relevant science programmes of potential hazards, geo hot spots, ecosystem processes, and oceanography: Arctic ocean, Norwegian margin, Nordic Sea, Porcupine Seabight and Abyssal Plain, MOMAR zone (Azores), Gulf of Cadiz, Ligurian Sea, East Sicily, Hellenic node, Black Sea, Marmara Sea (figure 1). The five former sites will be presented: scientific issues, infrastructure and their possible future as deep sea observatory. The Ligurian site has already been described in a previous article ([3]) and some updates will be given. As it is partly linked with the Antares neutrinos telescope and the KM3net project the link with the Hellenic node will be explained. The Black Sea activity in ESONET is still seldom. The East Sicily node is managed partly in the framework of an ESONET demonstration mission named LIDO (http://www.esonet-noe.org/main_activities/demonstration_missions). LIDO raised from a need to understand more about the role of sound production and reception in the behaviour, physiology, and ecology of marine organisms. Anthropogenic sound, including sound necessary to study the marine environment, can interfere with the natural use of sound by marine organisms. The Marmara zone is one place where great ESONET activity takes place, in the framework of an other Demonstration Mission, named MARMARA –DM, focused on Seismic science. A specific attention will be paid on this 2 Mediterranean Demonstration missions and on testing operations to be deployed on cabled sites.

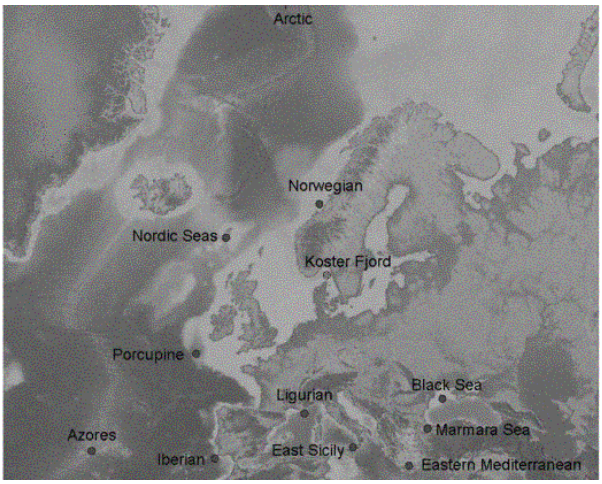


Fig. 1. Eleven ESONET nodes plus one testing site (Kosterfjiord)

Launched the 1st march 2007, great progress has been driven regarding all this issues on the ESONET sites. Here will be presented an overview of the progress made on Mediterranean sites and of the possible infrastructure at European scale. The conclusions will explain how this European observatory initiative is well integrated in a world wide "Deep sea observatory wave".

References
1 - Ruhl H.A., Karstensen J. , Géli L., Colaço A. , Lampitt R.S. and André M., 2009, Societal need for improved understanding of climate change, anthropogenic impacts, and geohazrd warning drive development of ocean observatories in European Seas. *Prog. Oceanog.*, submitted
2 - Waldmann C., Tamburri M., Prien R.D. and Fietzek P., 2009. Assessment of sensor performance, *Ocean Sci. Discuss.*, 6: 1687-1716
3 - Puillat I. , Person R., Leveque C., Drogou JF. Diepenbroek M., Garreau P., Waldmann C. and Auffret Y., 2009, Standardization prospective in ESONET NoE and a possible implementation, on the ANTARES Site, *Nucl. Instrum. Meth. A*, 602: 240–245

MODELING CARBON CYCLING AND SEQUESTRATION IN THE ADRIATIC SEA

Stefano Querin [1]*, Gianpiero Cossarini [1], Cosimo Solidoro [1] and Alessandro Crise [1]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS - Sgonico/Zgonik (TS) - Italy - squerin@ogs.trieste.it

Abstract
Biological and continental shelf pump play a major role in carbon cycling and sequestration in the intermediate and deep layers of the sea. A state of the art numerical model of the Adriatic Sea general circulation is coupled with a biogeochemical model to study and quantify these processes. Two scenarios are examined in detail: winter 2006/2007 and winter 2007/2008. In the former, mild weather conditions did not trigger any relevant dense water flux, which, instead, has been measured for the 2007/2008 case study. The results of the simulations show different biogeochemical properties and different air/sea CO_2 exchange rates, both in good agreement with experimental observations.
Keywords: Adriatic Sea, Carbon, Models

Marine systems play a crucial role in the global carbon budget, in particular, the oceans are thought to absorb about 40% of the antropogenic CO_2 [1]. The biological pump and the continental shelf pump are two among the mechanisms that foster the transport of carbon in the intermediate and deep layers of the sea (Fig. 1). The components of these processes are:
- primary production (PP) which uses the carbon (DIC) taken up through air/sea exchanges;
- sinking of organic material (POC);
- vertical transport of dissolved organic (DOC) and inorganic (DIC) carbon through downward fluxes associated with dense water formation.

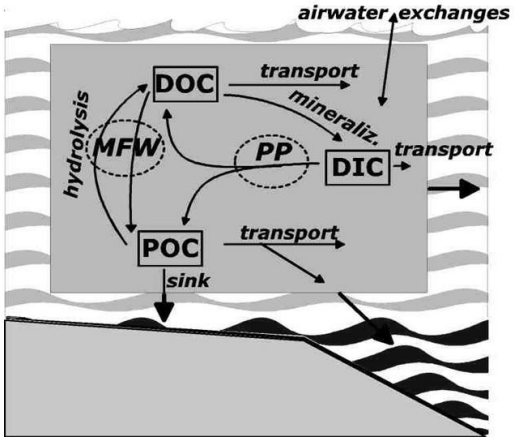


Fig. 1. Simplified scheme of the biological and continental shelp pump

The Adriatic Sea is considered to be a key area for the sequestration of atmospheric carbon in the interior of the Mediterranean Sea. This study presents the results obtained by running a numerical model of the Adriatic Sea for the period november 2006 - august 2008. The simulations, set up in the framework of the VECTOR project, aim at understanding the dynamics and fluxes of the biogeochemical properties of the basin, paying particular attention to the formation and transport of dense water masses (~7°C, 38 psu, 1030 kg/m^3), which originate in the Northern Adriatic Sea in winter and spread southward along the basin. Model features can also help in investigating the seasonal variability of the mesoscale structures and the effect of air-sea interactions on the general circulation.

The simulations are carried out customizing the MITgcm, a three-dimensional, finite volume, non-hydrostatic, general circulation model [2]. The physical model is coupled with a medium complexity biogeochemical model specifically developed for the Adriatic Sea [3] and a model which solves the carbonate chemistry system [4]. The computational domain spans north of the Otranto strait (from latitude 40.3° N to 45.9° N), with a horizontal resolution of 1/32° (~3.4 × 2.4 km) and 51 unequally spaced levels. Initial and open boundary conditions are obtained from the 1/16° operational model of the Mediterranean Sea run by INGV. The main rivers flow rates are derived from in situ measurements (when available) or yearly averages and are modeled in such a way as to consider both the thermohaline and momentum contribution. Surface atmospheric forcing is interpolated from high resolution atmospheric models (ETA006 and ALADIN).

The physical model reproduces the mesoscale seasonal variability correlated with the thermohaline properties of the water column. Short term (few days) response to the major atmospheric forcings (Bora and Scirocco wind) also show a good agreement with experimental observations. The biogeochemical model simulates carbon and phosphorus cycles paying particular attention to production, sinking and recycling processes.

The integrated model has been tuned to reproduce several experimental observations related to different environmental conditions. In particular, two scenarios are examined in detail: winter 2006/2007 and winter 2007/2008. In the former, mild weather conditions did not trigger any relevant dense water flux, which, instead, has been measured for the 2007/2008 case study. For both scenarios, the carbon budgets are estimated in three relevant sub-basins, vertically organized as follows:
- northern continental shelf;
- central pits (subdivided into 2 sub-layers);
- southern pit (subdivided into 3 sub-layers).

The results of the simulations show different biogeochemical properties and dynamics for each of the six boxes, and different air/sea CO_2 exchange rates, both in good agreement with experimental observations.

References
1 - Millero F.J., 2007. The marine inorganic carbon cycle. *Chem. Rev.*, 107: 308-341.
2 - Marshall J.C., Adcroft A., Hill C., Perelman L. and Heisey C., 1997. A finite-volume, incompressible Navier-Stokes model for the studies of the ocean on parallel computers. *J. Geophys. Res.*, 102: 5753-5766.
3 - Cossarini G. and Solidoro C., 2008. Global sensitivity analysis of a trophodynamic model of the Gulf of Trieste. *Ecol. Model.*, 212: 16-27.
4 - Follows M.J., Ito T. and Dutkiewicz S., 2006. On the solution of the carbonate chemistry system in ocean biogeochemistry models. *Ocean Model.*, 12: 290–301.

A FORCED OCEAN-ATMOSPHERE MODEL TO PERFORM LONG-TERM HYDRODYNAMIC RESPONSE INDUCED BY ATMOSPHERIC FORCING WITHIN THE STRAIT OF GIBRALTAR.

Emma Reyes [1]*, Miguel Bruno [1] and Alfredo Izquierdo [1]
[1] University of Cadiz, Applied Physics Department, 11510, Puerto Real, Spain - emma.reyes@uca.es

Abstract
This study investigates the response of the Atlantic inflow induced by atmospheric forcing in the Strait of Gibraltar during intense and persistent easterly wind episode. The hydrodynamic response is successfully simulated using a high-resolution oceanic numerical model forced by an atmospheric mesoscale model. Numerical simulations show the raising of the Atlantic-Mediterranean interface along the Morocco's northern coast indicating the development of upwelling in this area while the interface sinks down near the downweling region in the south Atlantic coast of Spain. The joint action of the high atmospheric pressure over the Mediterranean and the easterly wind drastically reduce the Atlantic inflow.
Keywords: Strait Of Gibraltar, Upwelling, Air-Sea Interactions, Atmospheric Input, Currents

Circulation in the Strait of Gibraltar consists of several concurring processes. One of these processes is the direct action of the winds along the Strait. Dominant easterly/westerly winds appear to originate upwelling/downwelling phenomena, which subsequently will modify the circulation patterns and the interface depth [1, 2 and 3]. It is known that under intense easterly winds upwelling events occur along the Morocco's northern coast while the downwelling is developed in the south Atlantic coast of Spain. Analysis of one month numerical simulations between September and October 2008, coincident with the GIBRALTAR-08 oceanographic survey period, were performed with a two-dimensional, non-linear, two-layer, free-surface, boundary-fitted co-ordinate, hydrostatic ocean model UCA2.5D [4] at grid resolutions down to 1 km, forced with the Fifth-Generation NCAR / Penn State N*on-hydrostatic*Mesoscale Meteorological Model MM5 [5] fields. The atmospheric model domain has been implemented for the Gibraltar Strait, covering the Western Alboran Sea and small part of the Gulf of Cadiz, while the curvilinear ocean model grid is limited to the Strait of Gibraltar and embedded in the larger atmospheric model domain (see Figure 1 for details).

Simulations have been performed with three different forcing cases to determine the response of the circulation patterns and the interface depth to the atmospheric pressure and wind forcing separately. The first simulation was performed by forcing the ocean model only with surface wind, the second simulation included also atmospheric pressure forcing and the third one has been obtained being forced by atmospheric pressure and surface winds. For the validation process, the different outputs of the model have been compared with a set of *in situ* meteorological and oceanographic data collected during GIBRALTAR-08 survey, which took place in the Strait of Gibraltar onboard the R/V Sarmiento de Gamboa conducted during fall season in 2008.

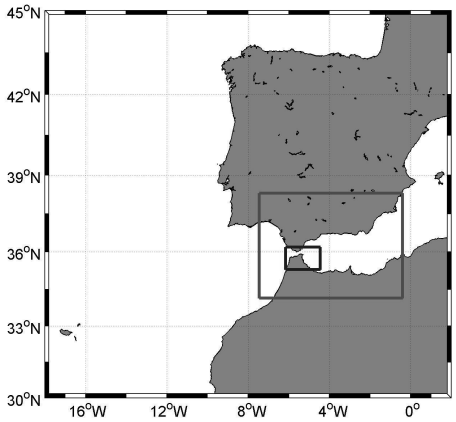


Fig. 1. Spatial coverage of the fine horizontal resolution (1 km in the whole model domain and 0.125 km in the Strait of Gibraltar) ocean model grid (blue box) and the 10 km horizontal resolution MM5 grid (red box).

Model simulations show that the effect of the easterly wind by itself is to decrease the intensity of the Atlantic inflow and the interface depth. Nevertheless, considering the joint effect of the high atmospheric pressure in the western Mediterranean basin, significant reductions in the Atlantic flow could therefore reverse at the same time that the Atlantic-Mediterranean interface raise, taking place the development of upwelling in the Morocco's northern coast. The numerical solutions closely match the experimental results discussed in [6].

References
1 - Peliz A., Teles-Machado A., Marchesiello P., Dubert J. and Garcia Lafuente J., 2009. Filament generation off the Strait of Gibraltar in response to Gap winds. *Dyn. Atmos. Oceans*, 46(1-4): 36-45.
2 - Vázquez A., Bruno M., Izquierdo A., Macías D. and Ruiz-Cañavate A., 2008. Meteorologically forced subinertial flows and internal wave generation at the main sill of the Strait of Gibraltar, *Deep Sea Res. I*,**55**: 1277–1283.
3 - Stanichny S., Tigny V., Stanichnaia R. and Djenidi S., 2005. Wind driven upwelling along the African coast of the strait of Gibraltar. *Geophys. Res. Lett.*, 32, L04604, doi: 10.1029/2004GL021760.
4 - Izquierdo A., Tejedor L., Sein D.V., Backhaus J.O., Brandt P., Rubino A. and Kagan B.A., 2001. Control variability and internal bore evolution in the Strait of Gibraltar: A 2D two-layer model study. *Estuar. Coast. Shelf Sci.*, 53 (1): 637-65.
5 - Dudhia J., 1993. A nonhydrostatic version of the Penn State / NCAR mesoscale model: Validation tests and simulations of an Atlantic cyclone and cold front. *Mon. Wea. Rev.*, 121: 1493–1513.
6 - García-Lafuente J., Delgado J. and Criado F., 2002. Inflow interruption by meteorological forcing in the Strait of Gibraltar. *Geophys. Res. Lett.*, 29: 20.1-20.4

DENSE SHELF WATER CASCADES IN THE PALAMÓS CANYON. COMPARISON WITH THE CAP DE CREUS CANYON

Marta Ribó [1]*, Pere Puig [1], Albert Palanques [1] and Claudio Lo Iacono [2]
[1] Institut de Ciències del Mar, CSIC, Barcelona, Spain - mribo@icm.csic.es
[2] Unitat de Tecnología Marina, CSIC, Barcelona, Spain

Abstract
The Palamós and the Cap de Creus submarine canyon heads were instrumented during two consecutive winters to study their respective role in the dynamics of the sediment transport on the northwestern Mediterranean Sea. Several events of dense shelf-water cascading (DSWC) were identified and compared among them. Sediment transport during DSWC at the Palamós canyon is significant during eastern and also northern storm events, but not related with river floods. However, the magnitude of transport events in the Palamós Canyon is one order of magnitude lower than in the Cap de Creus Canyon.
Keywords: Sediment Transport, Continental Margin, Western Mediterranean

Submarine canyons incised in continental margins are meant to be preferential pathways for the exchange of water and particles between the coastal area and the open sea. Hydrodynamics and sediment transport processes in submarine canyons depend upon several forcing conditions in the region such as general circulation, bottom morphology and atmospheric regime [1, 2]. The off-shelf sediment transport through submarine canyons, due to storms and river floods, can be significant and recently dense shelf-water cascading (DSWC) has been identified as an important transport mechanism able to generate high sediment fluxes in submarine canyons [3]. DSWC can transport large amounts of water and sediment, reshape submarine canyon floors and rapidly affect the deep-sea environment [4]. DSWC is seasonal, resulting from the formation of dense water by cooling and/or evaporation over the shelf, and occurs on both high- and low-latitude continental margins. The aim of this study is to determine the presence of DSWC events at the Palamós canyon head during winter conditions, and to compare these events with the contemporary ones recorded in Cap de Creus canyon head.

The Cap de Creus Canyon, located at the northwestern Mediterranean Sea belongs to a complex network of submarine canyons cutting the Gulf of Lions continental margin. The Palamós canyon is located 20 km southward from the Cap de Creus canyon. The head of both submarine canyons reaches the continental shelf-edge by the 90 m depth contour, and the canyon rims are about 2 - 3 km away from the coastline (Figure 1). At the southern end of the Gulf of Lions, storm-induced downwelling can be combined with DSWC and enhance sediment transport through submarine canyons during winter-time [3]. The Cap de Creus submarine canyon has been intensively studied during the past years as it acts a major transport conduit during DSWC events. On the contrary, little information exists about the sediment transport processes operating within the Palamós submarine canyon [5].

Observational work during this study consisted of a series of field measurements carried out with two instrumented moorings during winters 2006-07 and 2007-08 deployed at the heads of the Palamós and Cap de Creus submarine canyons around 300m depth (Fig. 1). These moorings were equipped with a current meter with temperature, conductivity, pressure and turbidity sensors, placed at 5 m above the seafloor. Multibeam bathymetry from both canyon heads was also acquired and used to determine the canyon axis morphology, which was considered to compute down-canyon fluxes. Forcing conditions were obtained from oceanographic buoys and gaps in the wave height and peak period time series were filled with models outputs. Daily river discharges from nearby rivers were also analyzed.

Sediment transport events during winter 2006-2007 and winter 2007-2008 were quite similar. Down-canyon current velocities >60cm/s were detected in the Cap de Creus Canyon, and >40cm/s in the Palamós submarine canyon. Increases in current speed were associated with subtle drops in temperature (~1 ºC) related to DSWC, and peaks of suspended sediment concentrations (SSC) of ~160 mg l^{-1} in the Cap de Creus Canyon, and ~6 mg l^{-1} in the Palamós canyon head. Two eastern storm events that generated temperature and current fluctuations were registered between 16th and 19th of February 2007 and between the 2nd and 5th of January 2008. These storm events enhanced DSWC events at both submarine canyons. A northern storm event on the 6th of March 2008 also occurred, but only generated DSWC at the Palamós, and not at the Cap de Creus Canyon.

During the study period there was no relation between sediment transport events and nearby river discharges. The amount of sediment transported during the DSWC events is one order of magnitude greater at the Cap de Creus canyon than at the Palamós Canyon. This corroborates the idea that most of the off-shelf sediment transport in the northwestern Mediterranean during DSWC events occur at the southwestern end of the Gulf of Lions, through the Cap de Creus Canyon [3, 4].

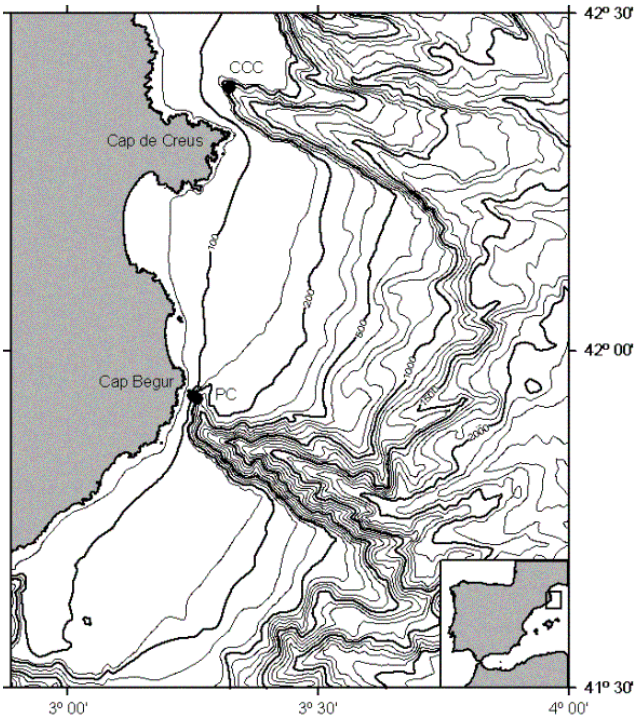


Fig. 1. Location of the two moorings in the Palamós Canyon (PC) and in the Cap de Creus Canyon (CCC).

References
1 - Puig P., Ogston A.S., Mullenbach B.L., Nittrouer C.A. and Sternberg R.W., 2003. Shelf-to-canyon sediment-transport processes on the Eel continental margin (northern California). *Mar. Geol.*, 193: 129-149.
2 - Xu J.P., Noble M., Eittreim S.L., Rosenfeld L.K., Schwing F.B. and Pilskaln C.H., 2002. Distribution and transport of suspended particulate matter in Monterey Canyon, California. *Mar. Geol.*, 181: 215–234.
3 - Palanques,A., Durrieu de Madron X., Puig P., Fabres J., Guillén J., Calafat A., Canals M. and Bonnin J., 2006. Suspended sediment fluxes and transport processes in the Gulf of Lions submarine canyons: The role of storms and dense water cascading. *Mar. Geol.*, 234: 43–61.
4 - Canals M., Puig P., Durrieu de Madron X., Heussner S., Palanques A. and Fabres, J., 2006. Flushing and reshaping submarine canyons by dense shelf water cascading. *Nature*, 444: 354-357.
5 - Martín J., Palanques A. and Puig P., 2007. Near-bottom horizontal transfer of particulate matter in the Palamós Submarine Canyon (NW Mediterranean). *J. Mar. Res.*, 65: 193-218.

LAGRANGIAN AND EULERIAN OBSERVATIONS OF THE SURFACE CIRCULATION IN THE TYRRHENIAN SEA

Eleonora Rinaldi [1], Bruno Buongiorno Nardelli [1]*, Enrico Zambianchi [2] and Pierre Marie Poulain [3]
[1] Istituto di Scienze dell'Atmosfera e del Clima (ISAC)-CNR, Rome, Italy - bbuong@gmail.com
[2] Dipartimento di Scienze per l'Ambiente, Università degli Studi di Napoli "Parthenope", Naples, Italy
[3] Dipartimento di Oceanografia, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS, Trieste, Italy

Abstract
In this paper the Tyrrhenian Sea surface circulation is investigated by means of lagragian and altimeter data. Respect to the traditional cyclonic circulation, the analysis reveals a significant and unexpected complexity. The circulation is modulated by a series of mesoscale/sub-basin structures, of both transient and semi-permanent nature. The pseudo-Eulerian statistics computed with the two datasets evidenced the representativeness of a joint analysis of altimeter and drifter data
Keywords: Circulation, Remote Sensing

Introduction
This paper focuses on the study of the Tyrrhenian Sea, a sub-basin of the western Mediterranean whose surface and near surface dynamics are still relatively poorly known [1, 2], in particular as to its southern region. A set of 53 surface drifters deployed in the Tyrrhenian Sea between December 2001 and February 2004 was analyzed. Simultaneous satellite remotely-sensed altimeter, covering the period 2001-2004, was associated to this dataset in order to supplement the drifter data with continuously and uniformly sampled observations, and to characterize the seasonal and the higher frequency variability of the surface circulation. The investigation was based on trajectory analysis and on the computation of the pseudo- Eulerian statistics using the same binning and space-time averaging for drifter and altimeter data.

Results and discussion
The analysis reveals a new more complex circulation pattern respect that drawn in literature [3, 4]. In fact the cyclonic circulation is modulated by a series of mesoscale/sub-basin structures, of both transient and semi-permanent nature. These structures are particularly important in the southern region of the basin where they overcome by far the mean flow pictures. The North Tyrrhenian Cyclone (NTC) and the North Tyrrhenian Anticyclone (NTA) are the main structures in the northern region of the Tyrrhenian Sea. In the south-western side of the basin a double core cyclonic gyre is present that captures the major portion of the AW entering in the basin. New structures of the circulation are picked out in the southern region of the Tyrrhenian Sea as the South Tyrrhenian Anticyclone (STA), between 12-13 E and 39-40 N, an anticyclonic circulation near the northern coast of Sicily, and finally a gyre having a cyclonic rotation offshore the Calabrian coasts.

The study of altimeter data has highlighted a certain degree of seasonal variability in the circulation pattern. The circulation structures present in the western side of the basin are stronger in summer than in winter, contrarily the circulation features in the south eastern region are more important in winter than in summer.

The pseudo-Eulerian statistic computed with drifter and altimeter measurements has highlighted the sampling and dynamical differences between this two dataset. The value of MKE is greater for the altimeter data than for drifters, on the contrary the EKE energy levels computed from the altimeter are lower than those obtained from drifters. To ascertain the consistency between the Lagrangian measurements and the altimeter dataset, and to evaluate if the observed differences can be related to different sampling capability or dynamical processes, the pseudo-Eulerian statistics derived from the drifters have been spatially smoothed and the altimeter data have been resampled along drifter trajectories. Altimeter data sampled over drifter trajectories and the spatially smoothed pseudo-Eulerian statistics derived from drifter have quite similar values of MKE levels of energy, but the variance ellipses and the EKE levels are very different, in fact the levels of energy computed from altimeter measurements are always smaller than those from drifters.

Therefore, it is possible to conclude that the standard interpolated products of altimeter data lose a considerable part of the signal, even if they ensure a wider and more regular sampling than drifters.

References
1 - Malanotte-Rizzoli P., et al., 1999. The Eastern Mediterranean in the 80s and in the 90s: The big transition in the intermediate and deep circulations. *Dyn. Atmos. Oceans*, 29: 365-395.
2 - Robinson A.R., Leslie W.G., Theocharis A. and Lascaratos A., 2001. Mediterranean Sea Circulation, *In:* Encyclopedia of Ocean Sciences, Academic Press, pp. 1689-1706
3 - Millot C., 1999. Circulation in the Western Mediterranean Sea. *J. Mar. Syst*. 20: 423–442
4 - Marullo S., Santoleri R. and Bignami F., 1994. The surface characteristics of the Tyrrhenian sea : historical satellite data analysis. *In*: La Violette, P.E. (ed) Seasonal and interannual variability of the Western Mediterranean sea. *Coastal and Estuarine Studies*, AGU, 46: 135-154.

ON THE FUTURE OF THE EASTERN MEDITERRANEAN TRANSIENT

Wolfgang Roether [1]*
[1] Univ. Bremen, Bremen, Germany - wroether@physik.uni-bremen.de

Abstract
The evolution of the Eastern Mediterranean Transient (EMT) to date has been documented in some detail. Presently, the deep waters are still in a transient state, with salinity distinctly enhanced relative to the classical situation. It is argued that, because of this, of long time scales of deep-water recirculation, and of expected climatic changes, transient conditions in the deep waters will prevail for a long time, with even an uncertain outcome. This contrasts strongly with the quasi-equilibrium situation that prevailed during the pre-EMT era.
Keywords: Eastern Mediterranean, Global Change

While our 1987 Meteor observations confirmed the classical view how the thermohaline system of the Eastern Mediterranean operated [1], the 1995 cruise (both cruises under the POEM umbrella) revealed the entirely disturbed situation [2] now known as the EMT. Dominant EMT features were a T-S inversion in the deep waters and a highly increased salinity over much of the water column, most strongly so below the inversion. A rather steady but far more moderate salinity increase was found also prior to the EMT (Fig. 1). However, T and S were always found to decrease with depth without any positive evidence of an inversion. The evolution after 1995 was further monitored by Meteor cruises in 1999 and 2001. The hydrographic observations (by OGS) together with our own tracer data and much information from other work revealed many remarkable features. One was the Aegean dense-water outflow in 1993 averaging as high as 3 10^6 m^3/s (3 Sv), related to isopycnals being raised by several hundred meters. The density of the Aegean-derived deep waters (referenced to an appropriate isobar) was hardly different from that of the classical Adriatic outflow [3]. Presently the deep waters are still far from an equilibrium state, and how the Eastern Mediterranean's thermohaline circulation will be organized in the long run is an open question.

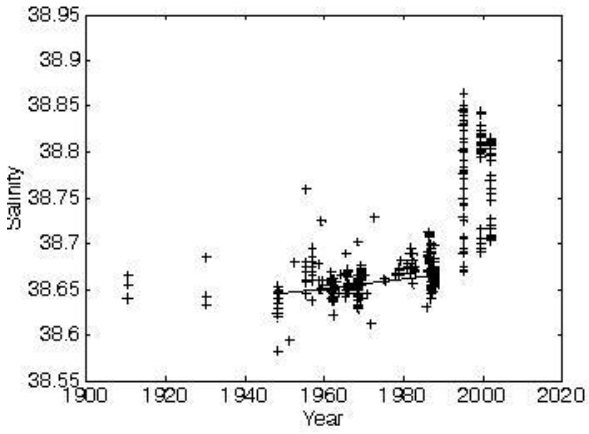


Fig. 1. Eastern Mediterranean salinities below 2000 m depth, 1910 – 2001 (courtesy B. Klein). Much of the scatter in the early data is measurement noise. The straight line is a linear fit to the pre-EMT data since 1948.

In this context, I address a potential paradigm change: During the period from the first observations (1910) up to the 1980s a quasi-equilibrium prevailed, proving to be basically stable against whatever disturbances occurred. The Adriatic acted as the principal deep-water source while the Aegean added to its preconditioning [3]. The deep waters generated formed one coherent cell of lateral spreading and upwelling. This structure was completely disturbed by the EMT (since about 1990), with the Aegean dwarfing the Adriatic as the deep-water source. It appears that the EMT was a unique event, brought about by accidental coincidence of a number of factors. After 1995, decreasing density restricted the Aegean outflow waters to mid-depths, which eventually enabled the Aegean to precondition the Adriatic again. However, a further ingredient is inclusion of upwelling deep waters. As its salinities distinctly exceed the pre-EMT values, the inclusion tends to raise salinity and density of deep waters newly formed. Considering that deep-water transports are governed by minute density differences, it is clear that such changes will modify the depths to which such waters penetrate and also their circulation pathways. The salinity increase has been highest in the Levantine deep waters, so that the effect will be strongest in the Aegean, which might help inducing another Aegean event. Reaching the Adriatic implies a delay on the order of 100 years [4], which, together with varying pathways and assisted by the moderate deep-water volume relative to those of the ocean at large, might induce oscillation. On such time scale, further salinity enhancement will arise from the expected regional decrease in precipitation [5]. I conclude that the deep waters will continue to be transient for a long time, and that even the outcome cannot be predicted with certainty.

Acknowledgements: It was Allan Robinson who, admirably, developed, together with Paola Malanotte-Rizzoli, the international cooperation that enabled the POEM effort, which made my Meteor work possible. Allan attended the Meteor cruises of 1987 and 1995. The OGS observations were directed by B. B. Manca, and in 1987, by the late A. Michelato. I am deeply indebted to all my coworkers in Bremen and at sea and to the EU and national funding agencies for support.

References
1 - Wüst G., 1961. On the vertical circulation of the Mediterranean Sea. *J. Geophys. Res.*, 66: 3261-3271.
2 - Roether W., Manca B.B., Klein B., Bregant D., Georgopoulos D., Beitzel V., Kovacevic V. and Lucchetta A., 1996. Recent changes in Eastern Mediterranean deep waters. *Science*, 271: 333-335.
3 - Roether W., Klein B., Manca B.B., Theocharis A. and Kioroglou S., 2007. Transient Eastern Mediterranean deep waters in response to the massive dense-water output of the Aegean Sea in the 1990s. *Prog. Oceanog*., 74: 540-571.
4 - Roether W. and Schlitzer R., 1991. Eastern Mediterranean deep water renewal on the basis of chlorofluoromethane and tritium data. *Dyn. Atm. Oceans*, 15: 333-354.
5 - Held I.M. and Soden B.J., 2006. Robust responses of the hydrological cycle to global warming. *J. Clim.*, 19: 5686-5699.

IN SITU DETECTION OF TSUNAMI AND OTHER SEA LEVEL RELATED HAZARDS - FROM A CONCEPTUAL APPROACH TO IMPLEMENTATION AT MEDGLOSS STATIONS

Sergiu Dov Rosen [1]* and Sagi Raz [2]
[1] Israel Oceanographic & Limnological Research and MedGLOSS Focal Center, Haifa, 31080, Israel - rosen@ocean.org.il
[2] Raz - Handasa Bio-medical engineering

Abstract
This paper presents first author's concepts for fast in situ detection of sea level induced hazards (tsunami, seiche, extreme sea levels, storm surge, extreme sea states, meteo tsunamis) and their implementation at sea level stations of MedGLOSS network. This is accomplished via real time low latency multi sensors (atmospheric pressure, wind, sea level) data gathering and by the processing and analysis of the data, using a specially developed software package. The basic idea is based on gathering the sensors data for a number of overlapping and time sliding windows of varying length and frequency and by analyses of cross correlations, trends, spectral and cross spectral data analyses.
Keywords: Sea Level, Tides, Time Series, Sampling Methods, Instruments And Techniques

Introduction
The importance of rapid detection and alert of tsunamis for providing early warning against such events has reached full recognition already at the first meeting of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS), because of the relatively small size of the Mediterranean Sea and the implicit short warning times for sites on its coasts. Along with the adopted decision for setting up a multi parameters and multi hazard early warning system, detection of these hazards using sea level monitoring sensors implicates continuous low latency monitoring of the sea level surface elevation at selected sites. While typical tsunami waves have wave periods from above 5 minutes to about 60 minutes (at least in the Mediterranean), there are additional infragravity waves in this wave period range of other origins which may superpose or be miss-identified as tsunami waves. Such infragravity waves can be due to bounded wave groups, as well as free waves such as edge waves, atmospheric pressure fluctuations (meteo-tsunamis), wind gusts, etc. Within the list of other hazards induced by sea level rise we may list flooding and/or coastal erosion due to storm surges via wind induced set-up (usually associated also with barometric lows), due to storm waves induced large superelevation within the surf zone (growing towards a maximum at the waterline) and extreme spring tides. Hazards due to sea level lowering, inducing coastal erosion and removal of various types of debris from the land and foreshore are due to tsunamis, while wind induced set-down or barometric highs may lead to navigation problems. It is thus obvious that the monitoring of sea surface fluctuations for the detection of tsunami waves must be capable to monitor at the same time other types of sea level fluctuations due to non-tsunamigenic origin and for this reason a low latency monitoring rate of the sea level is compulsory.

Paper contents
The paper will discuss the following aspects:
a. Monitoring and proper identification methods of the type of sea level hazard as a function of the location of the monitoring station (deep water, transient depth, surf zone, inside a harbour).
b. Present approach used for detection of tsunami waves in deep water for early warning.
c. The conceptual approach used for detection of tsunami waves in deep water as well as near the shore, separately for each type of location.
d. The sensors complementary to tide gauges, sampling rates and methods of data processing for rapid identification of sea level hazards.
e. Conceptual approach used for rapid detection of the hazards, including multi size and overlapping sliding data windows and the short term trend analyses, identification of the infragravity waves due to bounded long waves via Smoothed Instantaneous Wave Energy History (SIWEH) analyses (Funke and Mansard,1979), run length (Battjes and Van Vledder, 1984), temporal and spatial group steepness via Hilbert transform (Haller and Dalrymple, 1995), etc.
f. The approach chosen for the development of the special software package for rapid detection of sea level related hazards using the low latency data from submerged Paroscientific pressure sensor, Aanderaa wind station and Setra barometer with which are equipped some of the real time MedGLOSS sea level stations selected for participation in the preliminary NEAMTWS tsunami detection pilot network.

To enable the above concepts, first the MedGLOSS RT MONITOR software real time clock data gathering, analysis and real time data transmission was developed by the second author based on the specifications of the first author, and implemented at a number of MedGLOSS stations using the National Instruments LabView software development package and cRIO-9072 CompactRIO Controller and Chassis Integrated System with WINDOWS XP PRO operating system.

Based on the low latency data gathered by the RT MONITOR software, a sequence of windows of the data, covering overlapping and the sliding time windows from 17 minutes to 1/2 day are used to for fast determination via trend analyses, spectral and cross spectral analyses, correlation and other statistical data analyses methods as indicated above, based on the observed data, when such event is encountered and the sources leading to the fast sea level changes (tsunami, infragravity waves, seiche, storm surge, etc.). Finally, in the case that such an event would be detected, a near real time warning communication via Internet will be generated.

References
1 - Battjes, J.A., and Vledder, V., 1984. Verification of Kimura's theory for wave group statistics, Proc. 19th ICCE, Houston, ASCE, 1, 642-648.
2 - Funke, E.R., and Mansard, E.P.D.,1979. Synthesis of realistic sea states in a laboratory flume, Hydraul. Lab. Tech. Rep. LTR-HY-66, Natl. Res. Council of Canada.
3 - Haller M.C., and Dalrymple R.A., 1995. Looking for Wave Groups in the Surf Zone, *Coastal Dynamics '95*: Proc. Intl. Conf. on Coastal Research in Terms of Large Scale Experiments, pp.8l-92, Gdansk, Poland – Sept. 8, 1995.
4 - Hudspeth, R.T., and Medina, J.R., 1988. Wave group analysis by Hilbert transform, *Coastal Engineering*, Vol. 1, 885-898.
5 - Mase H., 1989. Groupiness Factor and Wave Height Distribution, *Journal of Waterway, Port, Coastal and Ocean Engineering*, Vol. 115, No. 1, January/February 1989, pp. 105-121.
6 - Symonds, G., Huntley, D.A., and Bowen, A.J., 1982. Two-dimensional surf beat: long wave generation by a time-varying breakpoint, *Journal of Geophys. Research*, 87, 492-498.

WINTERTIME CROSS SHELF CIRCULATION AND SHELF/SLOPE INTERACTION OFF THE CENTRAL ISRAELI COST

Zvi Rosentraub [1]*, Ayal Anis [2] and Ron Goldman [1]
[1] Israel Oceanographic & Limnological Res., POB 8030, Haifa, 31080 Israel. - zviros@ocean.org.il
[2] Depts. of Marine Sciences and Oceanography, Texas A&M university, Galveston, TX 77551,USA

Abstract
Results are presented from two field experiments, conducted during winters 2007/8 and 2008/9, and modeling work focusing on winter cross shelf and slope transport processes off the central Israeli coast. Our study shows that this transport is, apparently, driven by both downwelling circulation off the Israeli coast and by the strong impact of the flow of the adjacent deep sea upon the flow over the upper slope and over the narrow Israeli shelf due to the presence of an along-slope jet, open sea meanders, and eddies.
Keywords: Continental Shelf, Levantine Basin, Circulation

Results from two field experiments, conducted during winters 2007/8 and 2008/9, and modeling work focusing on winter cross shelf and slope transport processes will be presented. Our study shows that this transport is apparently driven by both downwelling circulation off the Israeli coast and by interaction between the flow over the narrow Israeli shelf and that of the deep sea. In comparison to studies of upwelling systems, downwelling driven circulation has been relatively little explored in the world ocean. Moreover, while modeling studies and a limited number of field experiments suggest that flow dynamics in the deep sea have a strong impact on the cross shelf/slope transport in the region, this has been only slightly explored [1, 2].

Field measurements included extensive hydrographic surveys using vessel-mounted and a vessel- towed ADCPs (acoustic Doppler current profilers) and CTD (conductivity, temperature, depth) casts off the central Israeli coast (depths from 10 to 800 m), long-term time-series measurements of water-currents and thermal structure in the water column from bottom mounted ADCP sites over the shelf (water depths of 25, 60, and 130m) and Aaanderaa RCM7 current meters moored at a site on the upper slope (300 m depth). Several thermistors were attached to the mooring line of the upper and shelf break sites. These measurements were complemented by forecasts and simulations using the Princeton Ocean Model (POM) with grid resolution of 1.25, nested within the eastern (ALERMO) and the general (OGCM) Mediterranean Sea models. This study is part of an ongoing US-Israel Binational Science Foundation funded project, which also includes microstructure and turbulent profile measurements aimed at combining the meso-scale and micro-scale transport and mixing processes.

The ADCP surveys revealed the temporal and high spatial variability of the currents on the shelf and slope region with length scales of O(10-20 km), accompanied by cross shelf transport due to the presence of eddies and onshelf intrusions of deep sea meanders up to the inner shelf. They also confirm the occasional existence of an along-slope northward baroclinic current jet during the winter season and provide important information about its structure. The surveys, with the help of the modeling simulations, show the along-slope jet to be part of the cyclonic jet following the eastern rim of the Levantine Basin during and following the southeastern winter storms or as a local intrusion of a deep sea current.

Measured velocities of the jet were relatively high with speeds as high as 1m/s and the jet was found to interact with the upper slope to produce strong northward currents close to the seabed. Data from the current meter sites showed that the downwelling flow over the shelf and at the shelf edge was mostly confined to the bottom boundary layer (BBL). This is believed to be due to the presence of seaward Ekman veering of the velocity within the BBL (vertical extent of 20-30 m) occurring during winter storms and during the relaxation period after the storms. The seaward flow at the BBL over the shelf break was found to be higher during the presence of an along-slope jet due to the stronger velocities over the seabed.

A persistent characteristic of the currents over the shelf break was the increase of current velocity with depth, resulting in a local maximum with speeds as high as 1 m/s at the top of the BBL. This local maximum is consistent with the existence of significant horizontal density gradients observed over the shelf break during the two winter experiments These density gradients were accompanied by a deep density front on the upper slope during the presence of the along-slope jet. Towards the end of the winter season the frontal jet weakened and the water column at the 300 m site became mixed, allowing for the strong upper layer currents to reach the bottom. Although the presence of both the along-slope jet and the downwelling circulation were well simulated by the numerical model, the strength of the jet was underestimated and the model failed to reproduce the observed increase of the current speed with depth over the shelf break.

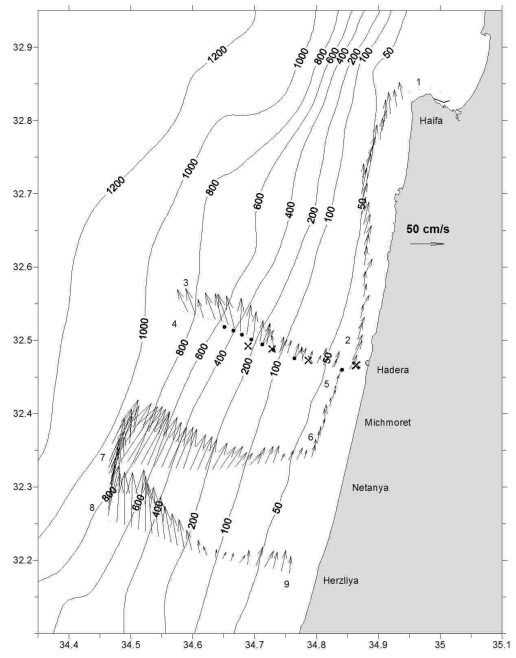


Fig. 1. Current vectors at -14 m from ADCP transects: 25 Feb 2009. Also shown are the positions of the CTD stations during the cruise (circles) and fixed current mooring stations during 17 Dec 08- 31 Mar 2009 (X).

References
1 - 1 - Rosentraub Z. and Brenner S., 2007. Circulation over the southeastern continental shelf and slope of the Mediterranean Sea: Direct current measurements, winds,and numerical model simulations. *J.Geophys. Res*. 112, C1101.
2 - 2 - Brenner S., 2003. High-resolution nested model simulations of the climatological circulation in the southeastern Mediterranean Sea. *Ann. Geophys.*, 21: 267-280.

INVESTIGATING CHANGES IN THE ATLANTIC WATERS CHARACTERISTICS ALONG THE EGYPTIAN MEDITERRANEAN COAST

M. A. Said [1]*, M. A. Gerges [1], I. A. Maiyza [1], M. A. Hussain [1] and A. A. Radwan [1]
[1] National Institute of Oceanography and Fisheries (NIOF), Alexandria, Egypt - mamsaid2@hotmail.com

Abstract
The paper investigates the changes in characteristics of the Atlantic Waters (AW) as they move eastwards along the Egyptian coast in the South-eastern Mediterranean. The study analyzed a long series of temperature, salinity and σ_t data, collected by several expeditions that were carried out by research vessels of different nationalities, including Egypt, during the period 1959-2008, averaged for the winter and summer seasons. The paper also examined the long-term (50 years) changes that occurred in the characteristics of the water masses off the Egyptian coast as a result of damming the Nile River in 1965 and the subsequent cessation of its discharge into the Mediterranean.

Keywords: Eastern Mediterranean, Temperature, Salinity, Time Series

The long-term (1912-1971) time series of data on the Nile River discharge into the Mediterranean before and after the construction of Aswan High Dam in 1964 showed that the average yearly discharge before damming was of the order of 62 km^3. The summer of 1964 witnessed the last normal Nile flood, which was exceptionally high and reached 63.73 km^3. From 1966 to 2007, the Nile discharge remarkably decreased to a yearly average of 3.92 km^3. Moreover, the annual cycle of the discharge has also changed from July or August to the winter months of December, January and February. Such a change in both the total amount and pattern of fresh water discharge to the Mediterranean would certainly affect the physical, chemical as well as the biological conditions of the southeastern part of the Mediterranean Sea.

In winter, the surface water temperature varied between 16.6 and 18.5ºC, with slightly colder or warmer spots. The surface salinity changes between 38.60 and 39.30, with a general trend of increasing eastwards. The most prominent feature of the salinity distribution at the surface is the presence of a nucleus of salinity > 39.00 that lies between longitudes 27-29ºE. This nucleus is characterized by low temperature (16.6ºC) and high density 28.7s_t. The above feature coincides with the location of the well-recognized gyre known as Mersa Matruh gyre. In summer, the surface water temperature varied between 22 and 28ºC. The area of slightly cold water is the area of the Mersa Matruh gyre. In order to study the vertical space variability of the hydrographic parameters, the average winter and summer values of each of the water temperature, salinity and density s_t were presented on a vertical section taken parallel to the Egyptian Coast along latitude 32º30'N and between 25º30' and 34ºE longitudes.

Only one surface water mass could be observed during winter in the upper 200 m layer. This surface water mass is characterized by temperature values ranging from 15º to17ºC, salinity maximum in the range of 38.90 - >39.10 and corresponding density values of 28.5-28.9 s_t. Three water masses could be observed in the upper 250 m layer in summer, as follows: The surface water mass, occupying the upper layer from 30 to 50 m depth, with temperature values of 22º to 28ºC and salinity 38.8 to 39.20. The subsurface water mass with temperature values of 16º to 22ºC and minimum salinity (<38.60-38.80). This water mass is of Atlantic origin, characterized by oxygen maximum of values >5.2 ml/l, and occupies the 50-150 m layer. Below this layer, the Levantine intermediate water mass (LIW) of temperature <16ºC and maximum of salinity (38.90-39.10) is clearly identified. These water masses were previously observed and discussed in detail by Said *et al.* [1]. Temperature and salinity anomalies indicated increasing trends for both temperature and salinity that reached 0.62ºC/dec and 0.067/dec, respectively for the Mediterranean surface waters, and 0.56ºC/dec for temperature and 0.035/dec for salinity for the Atlantic water (Fig.1).

Millot [2], using an autonomous CTD set at 80 m depth on the Moroccan shelf to monitor the inflowing AW during the period 2003-2007, found that the AW has encountered considerable salinification at the rate of about 0.05/yr, i.e. ~0.2 in the 4-year period of observation. The obtained results confirm that the increase of temperature and salinity of AW with time are attributed to both anthropogenic modifications, especially the Nile damming, and the local climatic changes, which need further investigation.

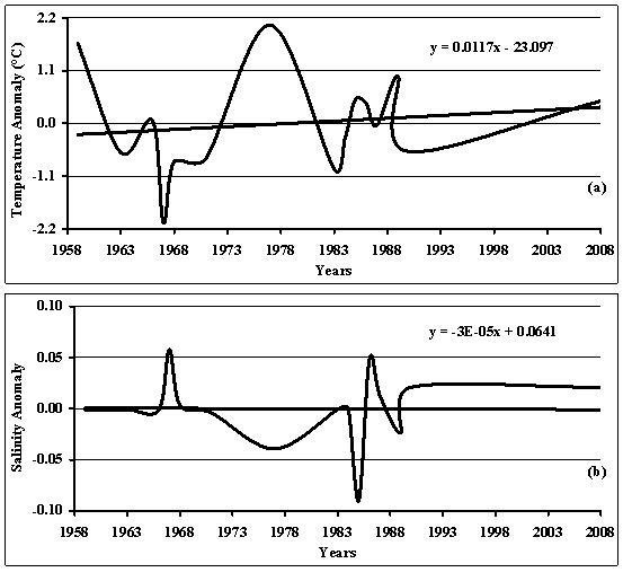


Fig. 1. **Time series from 1958 to 2008 of (a) temperature and (b) salinity for the Atlantic waters**

References
1 - Said M.A., Maiyza I. A., Hussain M. A. and Radwan A.A., 2007. Characteristics of the Egyptian Mediterranean water masses during the cold and warm winters. *J. Acta Adriat.*, 48 (2): 145-159
2 - Millot, C. 2007. Interannual salinification of the Mediterranean inflow, *Geophys. Res. Lett.*, 34, L21609, doi: 10.1029/2007GL031179.

CLIMATE CHANGE AND MARITIME INDUSTRY

Fani Sakellariadou [1]*
[1] Dept of Maritime Studies, University of Piraeus, Piraeus, Greece - fsakelar@unipi.gr

Abstract
Climate change is regarded as one of the major environmental and socioeconomic issues that Earth has to face. Maritime industry contributes significantly to the global greenhouse effect as shipping emissions are increased significantly with time. Efforts have to focus on green shipping initiatives under an international and holistic approach.
Keywords: Atmospheric Input, Global Change, Pollution, Temperature

Nowadays, climate change represents one of the greatest environmental and socioeconomic threats of Earth. It is the product of natural processes, responsible for long-term climate fluctuations, and anthropogenic activities, that over the past several decades had a rapid increase in global average temperatures. Human influences are related mainly to ozone layer depletion and greenhouse effect reinforcement. There is a general tendency for a global agreement to control climate change, reduce further human impact and find all possible ways to achieve a reasonable adaptation to the current change.

Maritime industry has various environmental effects associated with the life cycle of the ships, the construction and use of ports and the carried goods. It affects the environmental quality of air, water and land. The most important pollutants are carbon dioxide, nitrogen oxides [1], sulphur dioxide, heavy metals, petroleum hydrocarbons, antifouling agents, particulates, invasive species from ballast water discharges, various scrapping materials including hazards. They are discharged from maritime traffic (cargo spills, oily bilge discharges, ballast water, antifouling paints and sewage), port activities (sewage, cooling waters, spills), solid waste (dumping), port construction and maintenance dredging, shipyards and repairing zone. Often, they lead to eutrophication, acidification and biodiversity loss. World maritime community focuses attention on the importance of shipping safety, maritime security and environmental health. Maritime industry has an effect to climate change mainly due to the greenhouse gases emitted. Although pollutant emissions from land based sources are gradually decreased, those from shipping are increased. In the coming future the situation will be worse, if no action will be taken, as transport at sea is increasing by an annual 5% on average. Last forty years, the world merchant fleet has grown by 70% while the transport has almost tripled [2, 3]. Respective problems are more severe in coastal areas and especially ports. Dirty smoke pouring out from ships funnels has a major impact on the air quality of coastal cities. Oxides emitted to the air are responsible for the acid rain that affects seawater pH in the semi-closed water basin of a port. The same does not apply to the open sea.

Considering the Mediterranean basin, the situation asks for an effective action to be taken, as the sea is a major oil transportation route. It is estimated that each year, up to one million tons of crude oil from accidental spills, illegal bunkering and tank cleaning practices, as well as inadequate harbour facilities are discharged into the sea. The effects of the respective pollution are very severe, as the Mediterranean, besides its rather small extent equal to the one per cent of the world's marine areas it is regarded as the biotope of up to six per cent of the total marine species, including some of the most endangered ones.

However, it has to be mentioned that shipping is basically an environmentally sound means of transport, able to carry large quantities of goods with a relatively low energy demand. Emissions of air pollutants from ships can be eliminated by applying engine technology innovations, using after treatment techniques, burning better quality fuel. Both, the adoption of air pollution prevention regulations and the application of economic tools will be very useful. The general concept of the environmental status stabilization and the further environmental quality improvement should also incorporate the general public awareness of the issue. Current research focuses on green shipping that considers limitation of ecosystem impacts from shipping activities, less fossil fuel dependence, promotion of renewable technologies and limitation of safety hazards. The matter asks desperately for an international as well as holistic approach.

Maritime industry, due to its international character, needs a global agreement to control its negative effects to the environmental quality. Such attempts have been made in the Marine Environment Protection Committee of the International Maritime Organization of United Nations. In addition, The European Union has also studied the various implications derived from an EU co-ordinated action aiming to the reduction of air pollutants emitted from ships.

Marginal external costs of air pollution from shipping can be estimated using the impact pathway approach that traces emissions through dispersion and environmental chemistry, exposure of sensitive receptors, impacts and economic valuation using the willingness to pay approach. These estimates could be very helpful especially as the contribution of shipping emissions to trans-boundary air pollution impacts is increasingly recognized.

References
1 - Corbett, J.J and Köehler, H., 2003. Updated emissions for Ocean Shipping. *J Geophys. Res.*,108(D20), 4650 doi:10.1029/2003JD003751.
2 - UNCTAD, 2005. Review of Maritime Transport. United Nations Conference on Trade and Development.
3 - Eyring, V., Köhler, H.W., van Aardenne, J. and Lauer, A., 2005. Emissions from international shipping: 1. The last 50 years. *J. Geophys. Res.*, 110, D17305, doi:10.1029/2004JD005619.

WINTER 2009. A NEW STEP IN THE WESTERN MEDITERRANEAN TRANSITION

J. Salat [1]*, M. Emelianov [1], P. Puig [1], J. Font [1] and J. L. Fuda [2]
[1] Institut de Ciències del Mar (CSIC), Barcelona, Spain - salat@icm.csic.es
[2] Centre d'Océanologie de Marseille (COM), Marseille, France

Abstract

The signal of Deep Water Formation (DWF) activity in winter 2009 has been tracked through the HydroChanges (HC) time series, particularly in the classical MEDOC point (HCM: 42°N, 5°E) and on the Catalan continental rise (HCC: 41°28'N, 3°40.4'E), and from CTD data obtained during three cruises during 2009. The results pointed out to an absence of cascading and a new step towards a salinisation of the WMDW newly formed by open sea convection in the western side of NW Mediterranean. The updated data reveal that older WMDW, slightly colder and less saline, has been displaced towards the SE. The salinity of the newly formed WMDW after winter 2009 was ~ 0.005 higher than the previous one, with a potential density increase of 0.002-0.004 kg/m^3.

Keywords: Deep Waters, Water Convection, Western Mediterranean

Introduction

A new structure of the WMDW since 2005 forming a 'hook' in the θS diagram has been extensively described in recent papers and summarized in the CIESM Monograph 38 [1], being one of the major effects of what has been termed as Western Mediterranean Transition (WMT). The structure of the WMDW shows three water types: a θS minimum below the LIW, corresponding to the WDMW before 2005, followed by a relative maximum of θS and a new relative minimum of θS at the bottom. This three points, or water types forming the 'hook' structure will be named respectively as 'O', 'N' and 'C' as in [2]. This presentation is devoted to the characteristics and distribution of the WMDW newly formed in winter 2009. To avoid confusions, the whole structure of the WMDW present before the 2009 modification will be indicated as PDW, and the contribution of this year as NDW.

Data available and results

After two relatively mild winters of 2007 and 2008 with almost no activity of DWF, HCM series from 2200 m depth, displayed an abrupt shift of S (+0.010) and θ (+0.040°C) between 13 and 15 February 2009 [3]. While θ slowly recovered the previous values, the S shift lasted at least until the end of May, when the mooring was recovered. Data from the HCC site, at 1850 m depth, showed similar shifts 5-6 days later (Fig.1). As in HCM, θ progressively recovered the old values and S was slightly reduced during the next months, but when the mooring was recovered in September, a difference of (+0.006) still persisted. Therefore, the potential density of the deepest layer suffered an increase between 0.002 and 0.004 kg/m^3 in 2009. Unfortunately no CTD probe was available during the recovery operation to examine the hydrographic structure above the mooring site.

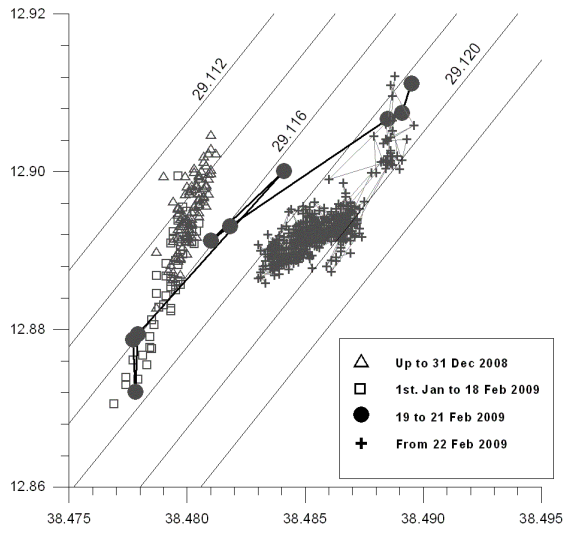


Fig. 1. θS diagram of the HCC series

In both HCM and HCC moorings near bottom currents and turbidity were also recorded. At the HCC site, the current was steadily slow (<10 cm/s towards the south) until 19 February. Then it became unstable with some fluctuations that lasted one week. After this instability episode the current shifted towards the SE during two weeks. After 7 March, currents recovered the southwards direction but with much stronger velocities (>30 cm/s) up to 12 March when slowed to <10 cm/s again. Suspended sediments were low except during the acceleration period (8-12 March), being consistent with a signal of local sediment resuspension.

Data from CTD casts in the NW Mediterranean after this DWF period were obtained in the framework of the FAMOSO Project in March (8-23), May (1-13) and September (14-20) 2009. Although sampling in those cruises was not dedicated to study the spreading of the newly formed WMDW (NDW), data obtained can be suitable for this purpose as there were several deep casts between HCM and HCC sites. The first CTD casts in March showed almost homogeneous waters from 0 to 2400 m in front of the Catalan coast (41°30'N, 3°30'E) with θ and S corresponding to the NDW values observed in the HC series. This NDW was present in several stations not only in March but also in May and still in September, at least in the NW sector. The thickness of the layer occupied by the NDW was higher (>300 m) in the stations located near the continental slope, becoming thiner towards the east and south. Accordingly, the whole PDW structure was displaced upwards and southeastwards.

Discussion

February 2009 has been much colder and windy than the two precedent years in the western side of the Gulf of Lions and along the Catalan coast. Northerlies were very frequent and some of them were very strong (*e.g.* the storm of 4-7 March with sustained winds of 40 m/s). Under such atmospheric forcings a response similar to that in winter 2005 could be expected, with strong convection and deep cascading. However, there is no evidence of this latter phenomenon in 2009, probably due to the water properties over the shelf at the beginning of the stormy period. While autumn 2004 and winter 2005 were very dry, autumn 2008 end winter 2009 were wet. Therefore salinity over the shelf had to be much lower than in 2005 thus preventing an excessive increase of the density. However, in open sea, the convection could be as active as it was in 2005 involving again important amounts of LIW over a large area, including zones near the continental slope where WIW formation typically takes place. For instance, the short time interval between the shift in HCM and HCC (less than one week for a distance of >120 km), or the structure found in the first CTD casts of the FAMOSO cruise in March, reveal a probable local origin of the perturbation. From now, the NDW reaching the bottom layer should mix with the C water type of PDW near the bottom contributing to a new increase of salinity in the bottom layer and pushing upwards, one step more, the O water type (from before the start of the WMT in 2005). As these O waters are located just below the LIW, a further decrease of the salinity of the intermediate waters reaching the western slopes can be expected in the following years, as it has been observed in the MOW at Gibraltar after the WMT.

References

1 - CIESM, 2009. Dynamics of Mediterranean deep waters. N° 38 in *CIESM Workshop Monographs* [F. Briand, Ed.], 132 pages, Monaco.

2 - Salat, J. Emelianov M. and López-Jurado J.L., 2007. Atypical Western Mediterranean Deep Water formation during winter 2005. *Rapp. Comm. int. Mer Médit.*, 38: 197.

3 - Fuda J.L, Bengara L., Ben Ismail S., Curtil C., El Moumni B., Font J., Lefevre D., Millot C. Taupier-Letage I., Raimbault P., Rougier G. Sammari C. and Tamburini C., 2009. Recent dense water formation in the Med western nasin, as observed by HYDROCHANGES. *In:* F. Briand (ed.), Dynamics of Mediterranean deep waters. *CIESM Workshop Monographs*, 38, pp 29-33.

EAST MEDITERRANEAN TRANSIENT AND DENSE WATER DYNAMICS IN THE AEGEAN SEA

Ettore Salusti [1]*, Volfango Rupolo [2] and Salvatore Marullo [2]
[1] Istituto Nazionale Fisica Nucleare, Roma, Italy - ettore.salusti@roma1.infn.it
[2] ENEA - CR Casaccia, Roma, Italy

Abstract

The relation between East Mediterranean Transient (EMT) and deep water formation in the Aegean Sea is studied using the last two decades of infrared satellite data, available hydrological data and a theoretical model based on the dynamics of density currents crossing and outflowing from a strait. The results of this analysis were then interpreted in the light of the simulations produced by a numerical model for the last 40 years.

Keywords: Deep Waters, Aegean Sea

Dense water formation processes play a fundamental role on the thermodynamics of the Mediterranean Sea. Such processes in the Aegean Sea are known from a very long time. Lacombe et al. [1] stated how the North Aegean very dense waters are probably renewed by the dense waters formed in wintertime in the gulf of Saros. Miller [2] reported deep temperatures from 10.0 to 14.5 ºC which, together with the high salinity, made this sea particularly interesting on thermodynamic grounds. El-Gindy and El-Din [3] estimated that about 50% of the dense waters in the Cretan Sea were originated in the Mount Athos region. Recently such processes received a remarkable attention as main sources of the Eastern Mediterranean Transient. During the CIESM Workshop on Dynamics of Mediterranean deep waters (Malta, 27 - 30 May 2009, published as CIESM Monograph 38), among other fundamental points attention was focused on the origin of this EMT. Some further analyses were therefore suggested as a detailed investigation about the dense water formation regions as the Cretan Sea, the Turkish shelf (Limnos Plateau) or the Northern Aegean (Samothraki Plateau). We therefore analyzed historical satellite images (year 1985-2009) of the whole Mediterranean Sea comparing sea surface temperature anomalies of the Adriatic Sea with the corresponding ones observed in the Aegean Sea. SST maps where kindly provided by the GOS laboratory of ISAC/CNR in Rome (http://gos.ifa.rm.cnr.it).

Then we used the available hydrologic data of the Aegean Sea to validate the results of such satellite comparison . We so obtain a yearly estimate of the dense water production of these two very thermodynamic seas, to check the original estimate of El-Gindy and El-Din [3]. One has to remark a fundamental difference between the Adriatic (with a rather simple and flat morphology) and the very complex Aegean sea bottom. There are some depressions, as the North Sporades Basin (~ 1500 m maximum depth), the Mount Athos Trough (~ 1000m maximum depth) and the Trough between Samothraki and Limnos (~ 1600 m maximum depth) in its northern part only, that can play the role of dense water reservoirs. These estimates are compared with results of recent numeric experiments [4] that interestingly evidence the role of the northern Aegean shelf dense waters on the basin thermodynamics and the importance of the Eastern Mediterranean Transient. Comparing numerical and satellite data we focus our attention on the possibility that similar but less intense outflows from the Aegean could have happened previously in the past. We finally study the effect of a novel version of the classical Bernoulli suction that takes into account entrainment and bottom friction [5] to emphasize outflow from a marine strait, as Antikithira, Kithira and Kassos [6].

References

1 - Lacombe, H., Tchernia P. and Benoist G., 1958. Contribution à l'étude hydrologique de la mer Egée en periode d'étée, *Bull. Inf., COEC*, 8: 454-468.

2 - Miller, A.R., 1974, Deep convection in the Aegean Sea. In Processus de formation des eaux oceaniques profondes en particular en Mediterranée occidentale. Paris, 4-7 Octobre 1972. Coll. Intern. CNRS, no 215, 155-163.

3 - El-Gindy, A.A.H. and El-Din S.H.S., 1986. Water nasses and circulation pattern in the deep layer of the Eastern Mediterranean. *Oceanol. Acta*, 9 (2): 239-248.

4 - Rupolo V., Carillo A., Artale V., Pisacane G., Sannino G.M. and Struglia M.V., 2009. Representation of the Eastern Mediterranean Transient and of the cyclonic circulation in the Ionian sea in the 1990's by means of a hierarchy of numerical models: A sensitivity study on surface fluxes, river runoff and Black Sea contribution. work in progress presented at this CIESM congress.

5 - Astraldi, M., Gasparini G.P., Gervasio L. and Salusti E., 2001. Dense water dynamics along the Strait of Sicily (Mediterranean Sea), *J. Phys. Oceanogr.*, 31: 3457-3475.

6 - Roether W., Klein B., Manca B.B., Theocharis A. and Kioroglou S., 2007. Transient Eastern Mediterranean deep waters in response to the massive dense-water output of the Aegean Sea in the 1990s. *Prog. Oceanogr.* 74 (4): 540-571.

A NEW BUOY FOR MEASUREMENT AND REAL TIME TRANSMISSION OF SURFACE SALINITY

J. Salvador [1], P. Fernández [1], A. Julià [1], J. Font [1]* and J. Pelegrí [1]
[1] Institut de Ciencies del Mar (CSIS),08003 Barcelona, Spain - jfont@icm.csic.es

Abstract
A surface buoy has been designed to measure temperature and salinity with high accuracy and transmit the data by satellite for a long period of time in studies of mesoscale or long scale oceanography. Prototypes have been built and tested in two different versions: to collect data close to the surface or at a depth of 100-150 m depending on the objectives of the experiment. These buoys are mainly used for Lagrangian measurements after being released from a vessel, although long duration tests have also been made with moored units mainly in the NW Mediterranean.
Keywords: Salinity, Temperature, Instruments And Techniques

Measuring oceanographic variables, mainly temperature and salinity, from drifting buoys is an important component in many process studies or long duration ocean circulation observations. Nowadays several kinds of buoys are manufactured to operate as surface drifters or profiling floats. But in both cases no commercial versions exist that provide sufficiently reliable salinity data close to the surface, since the occurrence of biofouling (in surface buoys) or the risk of surface particles being ingested into the measuring circuit (in profiling floats) can easily degrade the accuracy of recorded data.

The Institut de Ciències del Mar (CSIC, Barcelona), as contribution to two different research projects (MIDAS, Microwave measurements and algorithms development for the SMOS mission, and CANOA, Upwelling current in NW Africa), has developed and further tested a platform to record oceanographic parameters and transmit them in real time. The main characteristic of the platform is its modularity and versatility.

The support structure is a 380 mm diameter buoy formed by two semispheres injected in propylene charged with glass fibre. The two halves are fixed through 24 points and an o-ring gasket to ensure water-proof sealing. Two eight-pin communication connectors can be adapted to each semisphere. The overall structure has been tested for pressure and confirmed a good behaviour up to 7000 hectopascals. To adapt the temperature-salinity (T, S) measurements probe an inox structure was added to the buoy with four union points and a support for the instrument (Fig. 1).

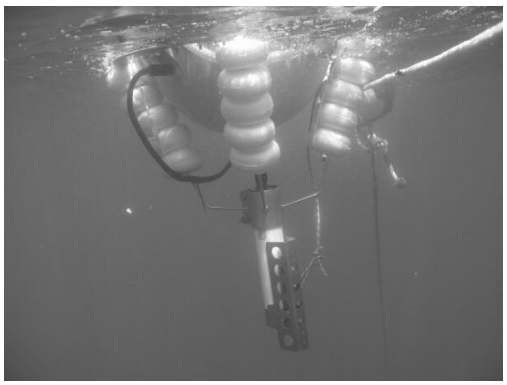


Fig. 1. Moored version of the buoy with the inox structure to attach the SBE37SI probe

This buoy has been used both in Lagrangian studies, transmitting data while drifting, and in Eulerian studies, moored in a fixed point. The Lagrangian version uses the same mechanical configuration than the SVP (Surface Velocity Program) drifter [1] adopted as standard by the World Ocean Circulation Experiment, it was deployed in the second cruise of the CANOA project in November 2008. Several configuratios were tested and one of them succeeded to record a surface (T, S) time series for over a year, this buoy still drifting and transmitting (T, S) data in early 2010. For Eulerian measurements one buoy was moored during 2007 and 2008 in the Medes islands, a small coastal archipelago in the NW Mediterranean, with very good results in terms of batteries duration and sensors stability. At present two units are moored in Las Cruces, Chile (September 2008, LINCG-Global project) and one in Colima, Pacific coast of Mexico (May 2009, EMPAM project).



Fig. 2. Preliminary prototype of the drifting buoy with an additional flotation in the line that connects to the standard cyclindrical drogue

The control electronics is formed by a Microchip 16F876A microcontroller that manages the data acquisition, implements a compression algorithm and sends the information to a SEIMAC X-CAT transmitter. The platform can adapt transmitters for the Orbcomm and GlobalStar systems, plus Argos that is the one now implemented. The system incorporates supercapacitors to use low cost batteries and to avoid sudden power decreases due to high energy consumption in short times (1 A during transmission).

The units built until now use a SeaBird microcat CTD probe, model SBE37SI. This instrument has a temperature drift of 0.0002ºC/month and a conductivity drift of 0.0003 S/m/month. The designed buoy can use any other sensor able to send data through a serial port, and can be also adapted to record analogic information.

This technological development has been mainly funded by the Spanish National R+D Plan through projects CANOA (CTM2005-00444/MAR) and MIDAS-4 (ESP2005-06823-C05). J. Salvador and P. Fernández acknowledge the support of the technicians formation program of the Spanish Ministry of Education and Science / Ministry of Science and Innovation.

References

1 - Niiler P P., Davis R. and White H., 1987. Water-following characteristics of a mixed-layer drifter. *Deep-Sea Res.*, 34: 1867-1882

SEA SURFACE TEMPERATURE AND SALINITY RISE IN THE LEVANTINE BASIN

Y. Samuel-Rhoads [1], S. Iona [2], G. Zodiatis [1]*, S. Stylianou [1], D. Hayes [1] and G. Georgiou [1]
[1] Oceanography Centre, University of Cyprus, Nicosia, Cyprus - gzodiac@ucy.ac.cy
[2] Hellenic National Oceanographic Data Centre, Institute of Oceanography, Hellenic Centre for Marine Research, Anavyssos, Greece

Abstract
Increases in sea surface temperatures (SSTs) have been recorded to occur globally, with the Mediterranean SSTs rising about twice as much as those of the global oceans. Here we analyse and compare satellite remote sensing SST data with in-situ data for the period 1996-2009 in the Levantine Basin. Further, temperature and salinity profiles from oceanographic cruises in this region were extracted from various databases, in order to study the interannual variability at the surface layer (0-10m). We show that the Levantine Basin has undergone SST as well as sea surface salinity (SSS) increases, during the last 14 years, occurring at both interannual and seasonal time scales. The driving mechanisms of these changes need to be investigated, as they may be driven by changes in latent heat losses and by the variability in regional wind speeds.
Keywords: Surface Waters, Temperature, Salinity, Remote Sensing, Levantine Basin

Preface
The reality of global warming since the industrial era is manifested in part by changes in global surface temperatures. Past studies have documented global SST increases between 0.3ºC and 1.0ºC over the last millennium [1], with the most rapid warming occurring over the past 30-40 years [2, 3]. Regional SST increases have also been reported in the Mediterranean for each of its two basins [4, 5]. Overall, SSTs across the Mediterranean as a whole have been rising about twice as much as those of the global oceans [6].

Results and Discussion
Analyses of annual mean SST data indicate that over the last 14 years (1996-2009) a general warming has occurred over the Levantine Basin, and occurred at an average rate of approximately 0.05°C per year. This increase in average SSTs is also seen in the seasonal averages, especially during the summer. Spatial variability in the decadal warming is depicted in the SST anomalies, with positive anomalies dominating most of the Levantine during the later part of the 14-year time period. An area southeastern of Cyprus is seen during some years to be warming up much more strongly than the rest of the Levantine Basin. This area corresponds with the Cyprus warm core eddy [7]. Empirical Orthogonal Function (EOF) analysis was performed on the seasonal SST data to examine their spatial and temporal patterns of variability, as well as on the annual data. The spatial eigenfunctions of mode 1 show that the seasonal and annual SSTs across the entire Levantine share high positive eigenfunctions and thus varied in a spatially coherent manner over time. Therefore, the SST variability is characterized by a broad, basin-wide warming (mode 1). The seasonal principal component (PC) of the same mode (PC1), which depicts the time variation of the first mode, varied over the years supporting the fact that the Levantine is experiencing a strong seasonal cycle. The PC1 of the annual data supports the fact that higher than average SSTs were observed across the Levantine during the later part of the 14-year time period. An asymmetry in the N-to-S direction is depicted in the spatial eigenfunctions of mode 2. Areas in the northern Levantine are out of phase from areas in the southern parts of the basin, creating a dipole pattern of heating and cooling at interannual and interseasonal time scales. Analysis of the in-situ SST and SSS data does not reveal any time-scale patterns. However, the pattern of in-situ SST variability is shared by the patterns of SSS. Further, satellite SST data are strongly correlated with the in-situ SST data. The driving mechanisms of these changes need to be investigated, as they may be driven by changes in annual latent heat losses and by the variability in regional wind speeds. Finally, it will be valuable to investigate future trends in SSTs to determine whether the observed patterns of SSTs represent a continued pattern of persistent warming or a new direction for an ever-changing Levantine Basin.

References
1 - Salinger M. J., 2005. Climate variability and change: past, present and future - An overview. *Climate Change*, 70: 9-29.
2 - Casey K.S. and Cornillon P., 2001. Global and regional sea surface temperature trends. *J. Clim.*, 14: 3801-3818.
3 - Trenberth K.E., Jones P., Ambenje P., Bohariu R., Easterling D., Klein Tank A., Parker D., Rahimzadeh F., Renwick J.A., Rusticucci M.M., Soden B. and Zhai P., 2007. Observations: Surface and atmospheric climate change. *In:* Solomon S., Qin D., Manning M., Chen Z., Marquis M., Averyt K.B., Tignor M., and Miller H.L. (ed.), Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, U.K. and New York, NY, USA, pp 235-336.
4 - Bethoux J.P. and Gentili B., 1999. Functioning of the Mediterranean Sea: past and present changes related to freshwater input and climate changes. *J. Mar. Syst.*, 20: 33-47.
5 - Tsimplis M. N. and Rixen M., 2002. Sea level in the Mediterranean Sea: the contribution of temperature and salinity changes. *Geophys. Res. Lett.*, 29: 51.1-51.4.
6 - Samuel-Rhoads Y., Monger B.C., Zodiatis G., and Greene C.H., in prep. Sea temperature rise in the Mediterranean Sea during the past two decades.
7 - Zodiatis G., Drakopoulos P., Brenner S., Groom S., 2005. Variability of the Cyprus warm core Eddy during the CYCLOPS project, *Deep Sea Res. II*, 52: 2897–2910.

SUBINERTIAL VARIABILITY OF THE EXCHANGED FLOWS AT THE WESTERN EXIT OF THE STRAIT OF GIBRALTAR

A. Sanchez-Roman [1], J. Garcia-Lafuente [1], F. Criado-Aldeanueva [1], J. Delgado [1], J. M. Vargas [1], J. Soto-Navarro [1], J. C. Sanchez-Garrido [1], C. Naranjo [1]* and C. Calero [1]

[1] Physical oceanograpy Group. University of Malaga. Malaga, Spain - cristina.naranjorosa@alum.uca.es

Abstract

Four year-long time series of Acoustic Doppler Current Profiler (ADCP) observations at a single station in Espartel sill have been analysed in order to investigate the subinertial flows through the Strait of Gibraltar. Estimated net flow at the western exit of the Strait has been compared with atmospheric pressure over the north eastern Atlantic (parameterised by the NAO index) and sea level pressure and wind-stress in the western Mediterranean. The main driving force is the atmospheric pressure over the Mediterranean Sea, although wind stress in the Atlantic side of the Strait may contribute appreciably to subinertial net flow.

Keywords: Atmospheric Input, Western Mediterranean, Water Transport, Strait Of Gibraltar

The western Mediterranean Sea is dynamically connected to the Atlantic Ocean through the Strait of Gibraltar. The excess of evaporation (E) over precipitation (P) and river runoff (R), together with the conservation of mass and salt in the Mediterranean basin drive the two-layer baroclinic exchange in the Strait. This exchange has been traditionally described as an inverse estuarine circulation [1] with an upper flow Q_1 of about 1 Sv (1 Sv = 10^6 m^3 s^{-1}) of fresh ($S_A \approx 36.2$) and warm Atlantic Water spreading into the Mediterranean basin, and a lower flow Q_2 of relatively cold and salty ($S_M \approx$ 38.4) Mediterranean Water. A long term barotropic flow $Q_0 = Q_1 - Q_2$ of the order of 0.05 Sv is necessary to balance the water deficit (E-P-R) of the Mediterranean Sea. The exchange is not steady but highly variable. According to the timescale of the process under study this variability has been traditionally classified into tidal, subinertial and long-term (seasonal and interannual). Subinertial flows, with periods from a few days to a few weeks or months, are mainly driven by meteorological forcing [2, 3] and are related to atmospheric pressure fluctuations over the western Mediterranean [4]. These flows are mainly barotropic (depth independent) although a baroclinic contribution can be identified due to the effects of local winds over the Strait.

In this work, ADCP velocity records collected over Espartel Sill (ES) are used to investigate the subinertial fluctuations of the exchanged flows at the western exit of the Strait of Gibraltar. Data from ES are the most recent recorded in the Strait. This station was placed at 35º 51.70'N, 5º 58.60'W in September 2004 and it is still acquiring information so five year-long time series are now available, this making the analysis of the flow seasonality a feasible task. A four year-long subset (from September 2004 until January 2009) has been used in this work. The ES station is part of the Spanish-funded INGRES project. The two-layer character of the exchange requires an interface definition to compute the transports. The easier and more obvious definition (after removing tidal fluctuations, which distort the two-layer exchange during part of the tidal cycle) is the surface of zero along strait velocity that separates water flowing into the Mediterranean and water flowing out. Subinertial velocities only reverse in very exceptional situations of extreme meteorological forcing. On the other hand, seasonal and interannual variability are always too weak to reverse flows. Therefore, the surface of null along-strait velocity is appropriate to carry out an analysis of the two-way exchange at subinertial frequencies [3]. ADCP data from ES were used to compute the Mediterranean outflow (more details in [5]) whereas the net flow (and hence the Atlantic inflow) were estimated from a mass-balance over the Mediterranean. Finally, atmospheric pressure and wind stress observations collected both in the Alboran Sea and the Strait of Gibraltar have been used together with the NAO index in order to analyse the response of the exchanged flows to the meteorological forcing and its seasonality.

The net flow has a mean value of 0.04 Sv at it presents a seasonal signal of around 0.04 Sv amplitude with maximum in September and minimum in March, similar than that obtained by [3] in the eastern Strait. The time-averaged Mediterranean outflow is -0.77 Sv with a maximum (absolute) value in April and minimum in November [5] (seasonal signal of 0.025 Sv amplitude). The Atlantic inflow was eventually estimated from both transports. It presents a mean value of 0.81 Sv with seasonality quite similar to that of the net flow. Meteorologically induced net flow fluctuations are chiefly driven by atmospheric pressure changes over the Mediterranean Sea showing a negative correlation that turns positive for the Mediterranean outflow due to the baroclinic response of the exchanged flows. Wind stress must be also taken into account since it may appreciably contribute to subinertial net flow.

References

1 - Stommel H. and Farmer H., 1953. Control of salinity in an estuary by a transition. *J. Mar. Res*., 12: 13– 20.

2 - Candela J., Winan C. and Bryden H. L., 1989. Meteorologically forced subinertial flows through the Strait of Gibraltar. *J. Geophys. Res*., 94: 12,667–12,674.

3 - Garcia-Lafuente J., Alvarez-Fanjul E., Vargas J.M. and Ratsimandresy A., 2002. Subinertial variability through the Strait of Gibraltar. *J. Geophys. Res*., 107(C10), 3168, doi:10.1029/ 2001JC001104.

4 - Crepon M., 1965. Influence de la pression atmospherique sur le niveau moyen de la Méditerranée Occidentale et sur le flux à travers le Détroit de Gibraltar. *Cah. Oceanogr*., 1: 15-32.

5 - Sanchez-Roman A., Sannino G., Garcia-Lafuente J., Carillo A. and Criado-Aldeanueva F., 2009. Transport estimates at the western section of the Strait of Gibraltar: a combined experimental and numerical modelling study. *J. Geophys. Res*., 114, C06002, doi: 10.1029/2008JC005023.

AN INTEGRATED STUDY OF THE EARLY-SPRING CARBON FLUX IN THE WESTERN MEDITERRANEAN SEA. RESULTS OF THE SESAME-IT4 CRUISE.

C. Santinelli [1]*, M. Abbate [2], B. Buongiorno Nardelli [3], G. Cerrati [2], S. Colella [3], F. Conte [2], E. De Domenico [4], R. Delfanti [2], G. P. Gasparini [5], R. Lavezza [1], M. G. Mazzocchi [6], M. Ribera D'Alcalà [6], K. Schroeder [5], A. Seritti [1], F. Smedile [4], C. Tamburini [7] and A. Zingone [6]

[1] CNR, Istituto di Biofisica, Pisa, Italy - chiara.santinelli@pi.ibf.cnr.it
[2] ENEA, Centro Ricerche Ambiente Marino, La Spezia, Italy
[3] CNR, Istituto di Scienze dell'Atmosfera e del Clima, Roma, Italy
[4] Dipartimento di Biologia Animale ed Ecologia, Università di Messina, Italy
[5] CNR, Istituto di Scienze Marine, La Spezia, Italy
[6] Stazione Zoologica "A. Dhorn", Napoli, Italy
[7] Laboratoire de Microbiologie, Biogéochimie et Ecologie Marines, UMR 6117, CNRS, Marseille, France

Abstract

The SESAME-IT4 cruise covered a large area of the Western Mediterranean Sea characterized by strong gradients. On the basis of satellite images and physico-chemical properties different regions were individuated. These regions showed also different biological populations. These data underline that DOC plays an important role in carbon fluxes in the Mediterranean Sea.

Keywords: Carbon, Organic Matter, Western Mediterranean, Surface Waters, Nutrients

The Western Mediterranean Sea is an area characterized by the strongest gradient observed in the whole basin. The analysis of the ten years climatological map of chlorophyll *a* shows that SESAME-IT4 survey covered regions characterized by very low Chl a concentrations exhibiting a sub-tropical regime (no bloom), as well as areas with maximum Chl-a concentrations (the Gulf of Lions), where intense blooms are observed [1]. The cruise was carried out in March-April 2008, which is the period characterized by the maximum biomass accumulation. Main goal of the survey was to get information on the functioning of different trophic systems in terms of biomass, nutrients, carbon accumulation and/or carbon export. Satellite images confirmed what we expected from the literature (high gradients and strong biomass accumulation). In particular the occurrence of strong variability and intense mesoscale activity was observed as well as an extended bloom in the northern part (> 40°N) of the study area. Another feature that emerged from satellite images is the occurrence of an anticyclonic eddy in the central part of the study area (S-IT4-008). In situ data evidenced that in the northern stations (>40 °N) water column was well mixed and the chimney of winter convection was still visible; in contrast in the southern stations, stratification was more pronounced. The evaluation of the residual nutrients confirmed that the bloom in the Gulf of Lions was still in progress.

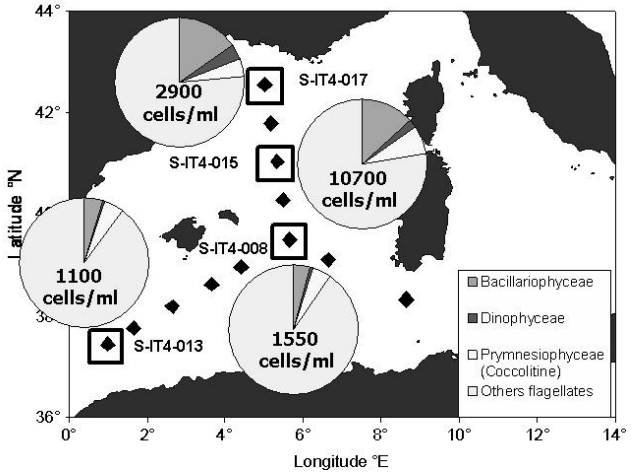


Fig. 1. Phytoplankton abundance and composition at the surface (5 m), superimposed to the map of sampling stations. The black diamonds indicate all the sampling stations (CTD, DOC, O_2, Nutrients), the black squares indicate the stations where biological parameters (phytoplankton, mesozooplankton, bacterial, abundance and composition) were also measured.

Phytoplankton abundance and composition showed that small flagellates dominated everywhere and that the composition was different between the northern and the southern stations with a higher percentage of diatoms (small non-colonial species) in S-IT4-0015 and S-IT4-017 (Fig. 1). In the microplankton fraction (cells> 20 µm) collected by net samples, Silicoflagellates dominated at S-IT4-017 and S-IT04-015, where the highest abundance of nanoplankton was also observed (Fig. 1). Mesozooplankton communities were numerically dominated by copepods in the whole area, but at S-IT4-015 salps also occurred with high abundance. These pelagic tunicates play an important role in C export, due to their high reproduction rates, efficient feeding on particles in a wide size-range, and production of large and fast sinking fecal pellets. The northern stations were also characterized by the highest bacterial abundance (14.1x 10^5 cells mL^{-1}) about twice that found below 41 °N.

Tab. 1. Integrated average in the layer 0-100 m for PO_4, NO_3+NO_2, POC and DOC. The ratio C.N and C:P were calculated by using the integrated average.

Station	PO_4	NO_3+NO_2	POC	POM	POM	DOC	DOM	DOM
	µM	µM	µM	C:N	C:P	µM	C:N	C:P
S-IT4-008	0.01	0.17	3.804	7	182	72	13	529
S-IT4-013	0.15	3.61	2.971	8	209	54	-	-
S-IT4-015	0.10	3.61	5.430	7	142	53	12	296
S-IT4-017	0.10	3.70	4.634	6	106	55	-	306

Despite the marked difference in biomass, POC fluxes were 70 mg C m^{-2} d^{-1} in S-IT4-017 and 38 mg C m^{-2} d^{-1} in S-IT4-008. A large gradient was observed in DOC, with a minimum (49 mM) in areas with a well mixed water column, a maximum (72 µM) at S-IT4-008 and values of 53-55 µM at the other stations (Tab. 1). As it is very probable that DOC production was very high in the northern stations, the low values observed there can be explained to some extent by the mixing and by very fast consumption due to the production of labile material and/or to a high efficiency of microbial loop. One interesting feature is that the C:P ratio in both POM and DOM was clearly affected by the trophic regime: low C:P ratios were found where PO_4 was available, suggesting the occurrence of POM and DOM rich in P and hence a less extent of P recycle; in contrast, in conditions of P limitation (S-IT08), most of the P available in the POM and DOM was efficiently used, resulting in higher C:P ratio (Tab. 1). The S-IT4-08, shows a peculiar behavior: here the nutricline was located at 150 m and the highest DOC concentrations were found (72 µM). TS properties evidence the presence of a different water mass, likely isolated by surrounding waters by the anticyclonic circulation. The low nutrients concentrations, the low biomass, the high C:P ratios in both POM and DOM and the high DOC concentration, all indicate an advanced stage of seasonal cycle. The accumulated DOC plays an important role in carbon fluxes because it can be transported below the mixed layer when the thermocline breaks. A rough estimate of the relevance of such transfer suggests that, in the Mediterranean Sea, the role of DOC in C export is comparable to that of POC .

References

1 - D'Ortenzio F. and Ribera d'Alcalà M., 2009. On the trophic regimes of the Mediterranean Sea: a satellite analysis. *Biogeosciences*. 6: 139-148.

HYDROCHANGES NETWORK: LATEST OBSERVATIONS AND LINKS BETWEEN TIME SERIES

K. Schroeder [1]*, V. Cardin [2], J. Font [3], J. Fuda [4], J. Garcia Lafuente [5], P. Puig [3], I. Taupier-letage [4] and ,. Others+ [1]
[1] CNR-Istituto di Scienze Marine, section of La Spezia, Italy - katrin.schroeder@sp.ismar.cnr.it
[2] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS, Trieste, Italy
[3] Centre d'Océanologie de Marseille (COM-LOB-CNRS), Marseille & La Seyne/mer, France
[4] University of Malaga (UM), Malaga, Spain
[5] Institut de Ciències del Mar, Barcelona, Spain

Abstract
HYDROCHANGES is an international program supported by CIESM (www.ciesm.org/marine/programs/hydrochanges.htm) initiated in 2002, to monitor the long-term variability of hydrographic properties of Mediterranean water masses – a priority in the context of global warming. We present an overview of the most recent observations and attempt to link the different time series.
Keywords: Hydrology, Time Series, Monitoring

HYDROCHANGES (HC) is a network of continuous, long-term measurements of temperature (θ) and salinity (S) in the Mediterranean. The HC monitoring strategy is based on *permanency*, to address the long-term variability, *key sites* to address specific processes, *simplicity of logistics* with a local management and short shiptime requirement for maintenance, and *simple instrumentation* (short moorings generally a few meters above the seafloor, supporting self-contained quality CTDs). Moorings are located in key places (Fig. 1) to track the signals indicative of specific processes driving the Mediterranean functioning, especially in straits and channels and in regions where dense water formation (DWF) occurs, either open-sea convection or shelf cascading. Data sets (Fig. 2) have been already widely exploited, also linking them with repeated CTD sections [1, 2, 3, 4, 5, 6].

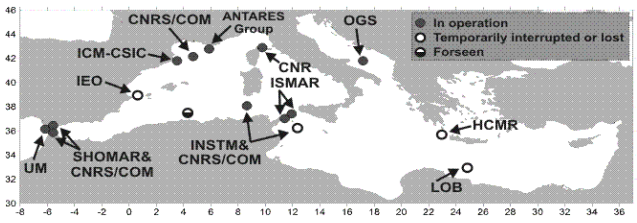


Fig. 1. Present status of the network and involved institutes.

There are some evidences of interannual θ (and S) increases (e.g., Fig. 2a, 2c and 2g), but the HC time series are too short yet to address issues on long-term variability. Nevertheless, they have demonstrated their relevance to accurately detect effects of DWF processes. This is particularly evident in the NW basin, showing the succession of offshore convection and shelf cascading in early 2005 and 2006 (Fig. 2). The mooring time series in the lower Catalan continental slope (Fig. 2g) recorded with unprecedented details the succession of episodes contributing to DWF in 2005: the arrival of open-sea convection water (positive jumps of θ and S in late January), the shelf cascading water (drop in θ and S in early March), and a warmer and saltier situation after April. Such a succession of events was recorded in 2006 too, while in early 2009 only signals pertaining to a less intense open-sea convection were recorded. The mooring at 42°N-5°E (Fig. 2f) also shows DWF in 2009, one week earlier, with an abrupt positive jump in θ and S in late February. The parallel marked increases of θ and S in the Sardinian Channel (SC) since summer 2005 (Fig. 2c) are likely to contain the remote signal of what happened in the northern part of the basin, with the new deep water slowly passing through the channel to reach the Tyrrhenian.

The various time series at Gibraltar (Fig. 2h) provide an insight in the interannual and seasonal variability of the outflow [3, 5] and inflow [4]. The latter has to be considered for DWF issues, as [4] reported a huge S increase (0.05/year) in the inflow between 2003 and 2007. In the outflow, the significant θ drop in March 2005 and 2006 might be directly related to a possible rapidly propagating barotropic response of DWF [6]. The monitoring of the Sicily Strait (SS) and the Corsica Channel (CC) is a fundamental task for the quantification of the highly variable heat and salt import from the Eastern Mediterranean, through the Tyrrhenian Sea, towards the western DWF sites (Fig.2b and 2d).

To improve HC we must add moorings in other key regions which are not currently monitored and add supplementary sensors to the CTDs (pressure systematically, oxygen and turbidity recommended). The complementary use of moored CTD vertical profilers would be a great asset, especially in the DWF areas. It requires also the dissemination of common practices (sampling frequency, processing, calibration frequency, archiving) and the set-up of a HC database and meta-database. The common access to all time-series would support efforts for linking the signals observed in both basins and at their connecting points, in order to get the comprehensive picture of the functioning of the Mediterranean. While it is likely to remain a long-lasting challenge, the precise monitoring of the θ and S is already providing reference data.

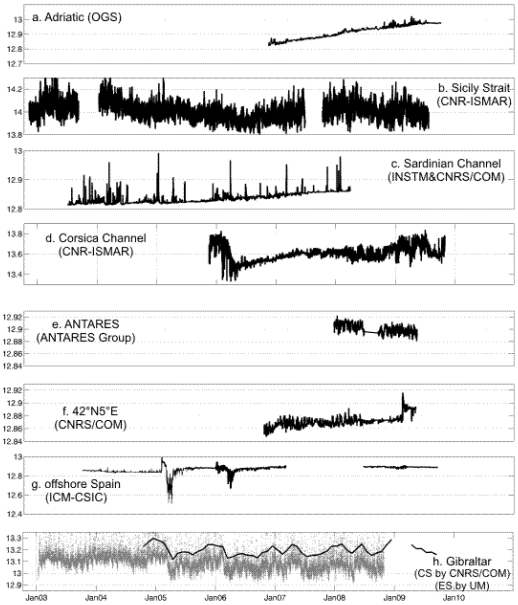


Fig. 2. θ times series in (a) Adriatic Sea, (b) SS, (c) SC, (d) CC, (e) ANTARES site, (f) 42°N5°E, (g) off Spain, (h) Gibraltar (Camarinal sill, CS, in grey, Espartel sill, ES in black).

+ L. Bengara, S. Ben Ismail, M. Bensi, Borghini M., C. Curtil, J. Delgado, C. Millot, B. El Moumni, J. G.P. Gasparini, D. Lefevre, J, Lopez-Jurado, P. Raimbault, G. Rougier, J. Salat, C. Sammari, A. Sanchez-Roman, C. Tamburini, A. Theocharis, M. Vargas-Yanez

References
1 - Font *et al.*, 2007. Sequence of hydrographic changes in NW Mediterranean deep water due to the exceptional winter of 2005. *Sci. Mar.*, 71(2): 339-346.
2 - Puig *et al.*, 2008. Dense shelf water cascades and sedimentary furrow formation in the Cap de Creus Canyon, northwestern Mediterranean Sea. *Cont. Shelf Res.*, 28(15): 2017-2030.
3 - García-Lafuente *et al.*, 2009. Interannual variability of the Mediterranean outflow observed in Espartel sill, western Strait of Gibraltar, *J. Geophys. Res.*, 114, C10018.
4 - Millot C., 2007. Interannual salinification of the Mediterranean inflow. *Geophys. Res. Lett.*, 34: L21609.
5 - Millot C., 2009. Another description of the Mediterranean outflow. *Progr. Oceanogr.*, 82(2):101-124.
6 - CIESM, 2009. Dynamics of Mediterranean deep waters. *In*: Briand F. (ed.), CIESM Workshop Monographs n.38, Monaco, 132 pages.

A "NATURAL" TRACER RELEASE EVENT IN THE WESTERN MEDITERRANEAN SEA

K. Schroeder [1]*, H. L. Bryden [2], G. P. Gasparini [1], M. Borghini [1] and A. Ribotti [3]
[1] CNR-Istituto di Scienze Marine, section of La Spezia, Italy - katrin.schroeder@sp.ismar.cnr.it
[2] National Oceanography Centre, Southampton, UK
[3] CNR-Istituto per l'Ambiente Marino Costiero, section of Oristano, Italy

Abstract

Oceanography is mainly an observational science where direct controlled experiments are hardly feasible. In the past some tracer release experiments have been carried out, that allowed to keep track of water parcels using stable compounds, in a classical lagrangian approach. Recently, intense deep water formation events in the western Mediterranean have produced high volumes of a new deep water, significantly warmer, saltier and denser than previously. These peculiar characteristics are mixing very slowly with the surrounding water and are still detectable in the whole basin. Thus, there has been a natural tracer release event where the tracer is temperature, or salinity, and for the first time we can track the evolution of the new deep water with standard CTD profiles, along its route from its formation region toward Gibraltar.

Keywords: Deep Waters, Western Mediterranean, Circulation

Since 2005 the deep waters of the western Mediterranean Sea (WMED) have experienced significant physical changes, which are likely to be caused partially by the Eastern Mediterranean Transient (EMT). This connection between the two basins, where one anomaly induced the other one decade later, may be a considered as a Mediterranean Sea Transient, MST [1].

The major change involved a change in the deep stratification, with an abrupt increase of temperature, salinity and density in the deep layers of the whole western basin [2]. The sharp signature (Fig. 1) provides for the first time the possibility to unequivocally identify the deep water formed during one specific winter throughout the basin, using only CTD data.

Repeat stations measured from 2005 to 2009 in wide regions of the WMED give the chronology of the new deep water spreading from its formation region towards Gibraltar and towards the Tyrrhenian Sea. Each year, the signature became evident in wider and wider regions, allowing a time-scale estimate of the spreading, which could only have been possible otherwise with a designed tracer release experiment. This time, the tracers are the sharp temperature, salinity and density increases in the bottom layer (Fig. 1).

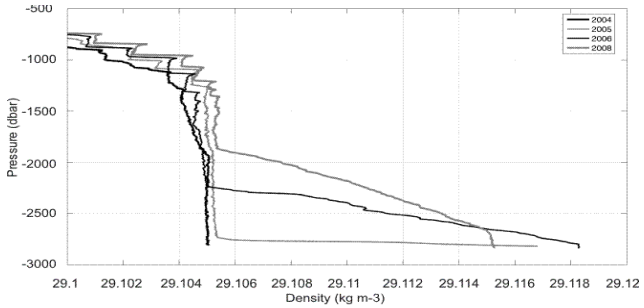


Fig. 1. Temporal evolution of the "tracer" signature (here density) south of the Balearic Islands.

For more than 25 years the scientific community is aware of the fact that the Mediterranean outflow is composed either by Levantine Intermediate Water (LIW), originating in the Eastern Mediterranean Sea (EMED), and by Western Mediterranean Deep Water (WMDW), which is aspired through the Strait of Gibraltar by Bernoulli suction [3, 4]. The direct outflow of the deep waters may affect the abyssal circulation of the Mediterranean Sea as well as the circulation of the adjacent ocean. In 2005 the new WMDW was found in a wide areas of the WMED, along its spreading pathway, even in the northern part of the Algerian subbasin and in stations near the entrance of the Alboran subbasin. In 2006 the new WMDW was present in almost the entire WMED, excluding the Tyrrhenian and the western Alboran subbasins. More recent data, collected in 2008, clearly show that the only subbasin that has not yet been reached by the new WMDW is the Tyrrhenian Sea. In 2008 the new deep water signature was found at the entrance of the shallower Alboran Sea (Fig. 2a), where its interface with the overlying water was at 950 m depth. Here the unequivocal identification of the winter-04/05 formed deep water near Gibraltar was possible thanks to the particular shape in the TS diagram. Therefore, its detection at about 100-150 km from the Strait of Gibraltar, allows an estimate of the temporal scales of its spreading: a deep water mass formed in February-March 2005 in the NW-MED has almost reached Gibraltar in 33 months.The fraction of new WMDW still seems to be very low and no signature could be found at stations west of Gibraltar. Nevertheless, the route of the WMDW hypothesized by [3] is confirmed. Indeed also the anomalous WMDW is flowing westward along the Moroccan continental slope, which is an indication of the anticyclonic Alboran gyre extending throughout the water column.

Most recent data (Nov. 2009) seem to detect an increase presence of the "tracer" along the axis of the canyon in the Sardinia Channel, on the way to the Tyrrhenian Sea (Fig. 2b). Fig. 2c evidences that the new WMDW has just got over the sill (1930 m) dividing the Algerian basin from the Tyrrhenian Sea.

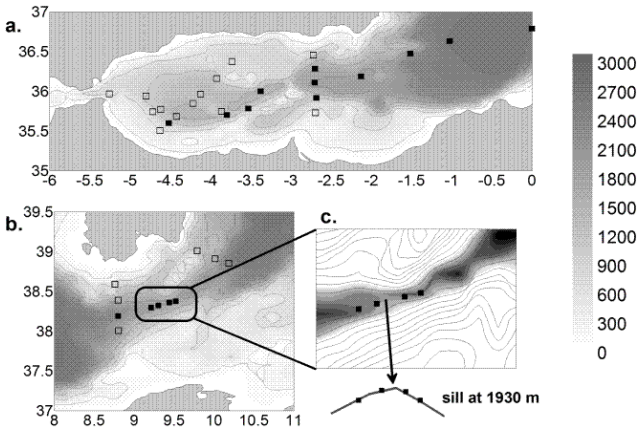


Fig. 2. CTD stations in (a) 2008 in the Alboran Sea and (b) 2009 in the Sardinian Channel, evidencing the spreading of the new WMDW (black squares = presence of new WMDW, empty squares = absence). (c) Zoom of the sill region in the Sardinian Channel (the bathymetric grey scale is for (a) and (b) only).

References

1 - Millot C., 2005. Circulation in the Mediterranean Sea: evidences, debates and unanswered questions. *Sci. Mar.*, 69 (1): 5-21.
2 - CIESM, 2009. Dynamics of Mediterranean deep waters. *In*: Briand F. (ed.), CIESM Workshop Monographs n.38, Monaco, 132 pages.
3 - Bryden H.L. and Stommel H.M., 1982. Origin of the Mediterranean outflow. *J. Mar. Res.*, Supplement to 40: 55-71.
4 - Kinder T.H. and Bryden H.L., 1990. The aspiration of deep waters through Straits. *In*: Pratt L.J. (ed.), The physical oceanography of sea straits. Kluwer Academic Publ., Boston, pp. 295-319.

VARIATIONS IN THE SEA SURFACE TEMPERATURE OF THE BLACK SEA DURING THE 20TH CENTURY

Georgy Shapiro [1]*, Dmitry Aleynik [2] and Laurence Mee [2]
[1] University of Plymouth, Plymouth, UK - gshapiro@plymouth.ac.uk
[2] Scottish Association for Marine Science, Oban, UK

Abstract
There is growing understanding that recent deterioration of the Black Sea ecosystem was partly due to changes in the marine physical environment. This study focuses on sea surface temperature variability over the 20th century. Results show that the deep Black Sea was cooling during the first three quarters of the century and was warming in the last 15-20 years; on aggregate there was a cooling trend. The Western shelf was more volatile and did not exhibit a statistically significant trend. The cooling of the deep Black Sea is at variance with the general trend in the North Atlantic and may be related to the decrease of westerly winds over the Black Sea, and a greater influence of the Siberian anticyclone. The timing of the changeover from cooling to warming coincides with the regime shift in the Black Sea ecosystem.
Keywords: Black Sea, Continental Margin, Deep Sea Basins, Temperature

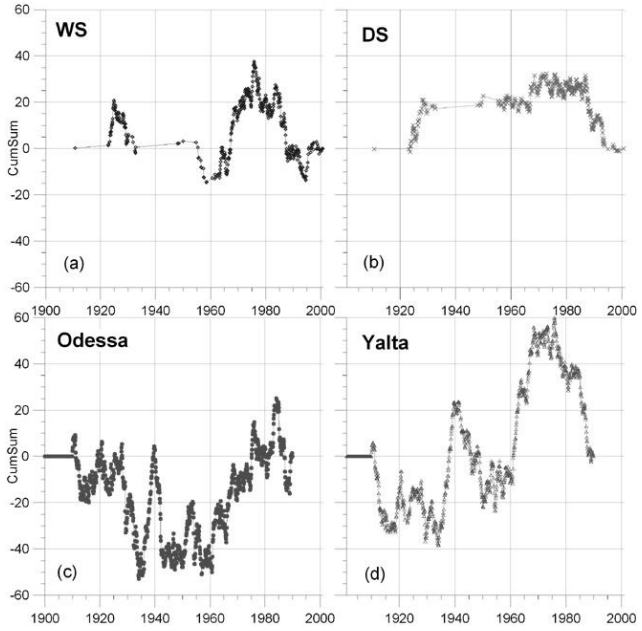


Fig. 1. The CUMSUM charts for aggregated temperature anomalies on the western shelf (a) and deep sea (b), and the CUMSUM charts for air temperature anomalies at coastal stations Odessa (c) and Yalta (d).

Introduction
Europe's four regional seas (the Baltic, Black, Mediterranean and North Sea) have all suffered major ecological change in the past three decades. The causes of degradation of the Black Sea ecosystem have been frequently cited as eutrophication due to increased fluvial nutrient load as a result of the Green Revolution [1] and the arrival of invasive species [2]. However, there is an increasing appreciation that current climate change can trigger a major response in the structure and function of marine ecosystems on a decadal timescales [3, 4, 5]. The warming of the World Ocean over recent decades has been firmly established [6]. In the Black Sea, studies of long term changes of the physical properties are sparse.

Data and methods
The source of data for this study was obtained from a number of reputable sources including the World Ocean Database 2001, the Romanian Marine Research Institute, the Goddard Institute for Space Studies and some others. In contrast to previous Black Sea studies, the monthly temperature anomalies rather than the absolute values are used as indicators of temporal changes in Sea Surface Temperature. The benefit of using anomalies is that unlike the absolute temperatures, the SST anomalies are highly correlated at stations separated as far as 1200 km [7]; this fact allows aggregating observational data over large areas of the Black Sea**.**

Results and Analysis
The SST and air temperature trends over the 20th century were estimated with both parametric and non-parametric statistical methods by calculating coefficients of linear regression, as well as Pearson, Spearman and Kendall-tau correlations. All four statistical methods clearly show that there was a definite cooling trend in the deep Black Sea over the 20th century at negative rate of (-0.86 ± 0.3) °C per 100 years. On the western shelf there is no statistically significant trend. The linear trend in the air temperature in the central Black Sea represented by the data set from Yalta weather station is negative showing a modest cooling at (-0.3 ± 0.1) °C per 100 years. In contrast to this, air temperature in the western Black Sea measured at Odessa weather station shows a positive trend at (0.3 ± 0.2) °C per 100 years. A further analysis using a CUSUM method has been carried out on an interannual and decadal scale showing a number of regime shifts in the deep Black Sea in years 1927, 1966, 1968, 1986 and 1997. On the western shelf, the regime shifts and the most significant cooling periods of the SST are associated with the most severe winters observed in 1947, 1954, 1985 and 1987. Unusual temperature trends in the Black Sea could be attributed to the variations in the overlying weather pattern, however the link is non-linear.

A relatively small (R=0.65) correlation coefficient between variations in air and sea temperatures exemplifies a non-linear response of the sea to changing weather conditions. The analysis of CUSUM charts suggests that it is the shifts in the established weather regimes on a decadal scale rather than interannual variations of meteorological forcing which lead to changes between warming and cooling phases of SST evolution, particularly in the shelf regions. The shelf and the deep sea response show different patterns of their responses to the weather conditions, which results in de-coupling of the SST variations of on the western shelves and the deep sea.

References
1 - Zaitsev Y.P. and Alexandrov B.G. , 1997. Recent man-made changes in the Black Sea ecosystem. *In*: Özsoy E. and Mikaelyan A. (eds.), Sensitivity to Change: Black Sea, Baltic Sea and North Sea. Kluwer Academic Publishing, Dordrecht, pp 25-31.
2 - Kideys A.E., 2002. Fall and rise of the Black Sea ecosystem, *Science*, 297 (5586): 1482- 1484.
3 - Daskalov G.L.,2003. Long-term changes in fish abundance and environmental indices in the Black Sea, *Mar. Ecol. Prog. Ser*, 255: 55-63.
4 - Oguz T. , 2005. Black Sea ecosystem response to climatic teleconnections, *Oceanography* 18(2): 122-133.
5 - Conversi A., Peluso T., and Fonda-Umani S. ,2009. Gulf of Trieste: A changing ecosystem. *J.Geophys.l Res*. 114, C03S90: doi:10.1029/2008JC004763.
6 - Levitus S., Antonov J. I., and Boyer T. P., 2005. Warming of the World Ocean, 1955-2003, *Geophys. Res. Lett.*, 32: doi:10.1029/2004GL021592.
7 - Hansen J.E. and Lebedeff S.,1987. Global trends of measured surface air temperature, *J. Geophys. Res.*, 92: 13345-13372.

LONG TERM VARIABILITY OF THE PHYSICAL PARAMETERS IN THE BENTHIC BOUNDARY LAYER OVER THE BLACK SEA SHELF

Georgy Shapiro [1]*, Friedemann Wobus [1], Dmitry Aleynik [2] and Claire louise Griffiths [1]
[1] University of Plymouth, Plymouth, UK - gshapiro@plymouth.ac.uk
[2] Scottish Association for Marine Science, Oban, UK

Abstract
The purpose of this study is to identify long-term changes of hydrological parameters in the benthic boundary layer (BBL) on the Western Black Sea shelf. This is done to provide underpinning information for the study of carbon cycle. Interannual variability and smooth changes in the parameters of the benthic boundary layer which are thought to be related to variation in rates carbon sequestration are assessed.
Keywords: Anoxia, Black Sea, Continental Shelf, Temperature

Introduction The chemical structure of the Black Sea waters is largely determined by the location and the strength of the pycnocline. The oxycline and the chemocline occur at the same depth intervals as the halocline, because of similarity in the mechanisms of vertical exchanges [1]. As the data for Dissolved Organic Carbon (DOC) on the shelf is sparse we test a hypothesis that a similar statement is valid for DOC, so that much abundant data on physical parameters can be used as proxy. We use the near-bottom temperature as indicators for physical conditions in the benthic boundary layer on the shelf. The physical reason for this is that interannual variations in the near-bottom temperature are directly related with the volume of cold waters [2] which are formed on the shelf and then exported into the deep sea. Despite early claims on possible shoaling of the anoxic interface, the vertical position and structure of the chemocline appear reasonably stable within the last few decades [3]. However, seasonal and interannual temperature and salinity variations do exist in the upper layer that are subsequently evidenced in the bottom boundary layer on the Western shelf due to winter convection.

Data and Methods
The majority of the available data suitable for the study of the BBL was taken on the extensive North West shelf, which is the focus of the present report. In this study we identified climatically averaged parameters on a dense horizontal grid of 0.25^o as well as monthly anomalies (deviations from the climatology) using over 17,000 stations. Water masses and the chemicals contained therein, which are located in the BBL on the shelf below the upper pycnocline are unlikely to surface due to vertical mixing process. The upper level of the bottom boundary layer was determined by the deepest level to which vertical mixing due to waves and wind can reach if the energy for mixing is limited by a certain threshold, which for this study was taken $10kJ/m^2$. We consider here the energy required to completely mix a water column as the difference between the potential energy of the stratified water column and the completely mixed water column. The constant density of the mixed water column can be derived from the original density profile using the principle of the conservation of mass, such that both potential energies can be expressed as a function of the measured density stratification.

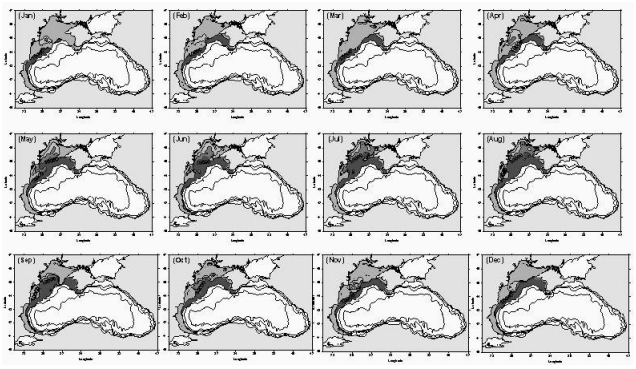


Fig. 1. Climate: shelf areas ($\leqslant$ 200m) covered by waters denser than the mixing depth (W_{mix} = 2,500/5,000/10,000 J m^{-2})

Results and analysis
Comparison of the available vertical profiles of nutrients, DOC and water density has shown that strong density stratification is linked to stratification in nutrients and DOC so that variation in physical parameters can be used as proxies for their biochemical counterparts. The layer below the upper pycnocline forms a 'communication channel' for nutrients and carbon to be removed from the shelf ecosystem. During the winter-early spring month the water masses contained within the 'communication channel' could come into contact with the oxygenated surface waters via isopycnal movement. However, during the summer-autumn month (May to November) these water masses are completely isolated from the surface. The areas on the shelf (depth <200m) which are occupied by the 'locked' BBL waters vary during the year as well as average temperature of these waters. For this study we are using temperature anomalies rather than absolute values to avoid statistical bias when aggregating the data over large geographical areas, such as western Black Sea shelf. The anomalies were calculated for a density range that was fixed for each summer month (May-November) using sigma-theta = 14.2 as a fixed upper limit and a lower limit was the shelf edge (i.e. 200m isobath).

The analysis allowed us to answer the following questions: (i) What are the areas of the Western BS shelf where the near-bottom waters can not be mixed vertically ('locked out water masses')? How these areas change from month to month ? What is the interannual variation of temperature in the locked waters? The intra-annual variability of the 'locked out' areas occupied by bottom waters and the inter-annual variation of the area –aggregated temperature anomaly are shown in Figs 1.and 2.

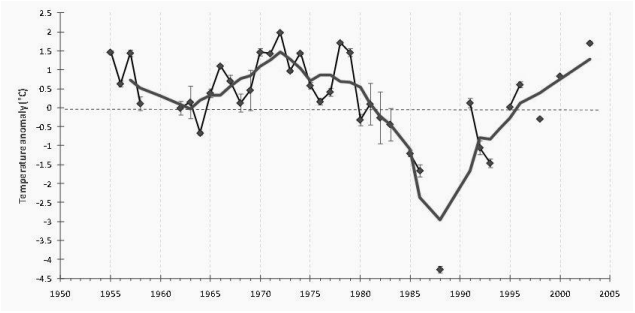


Fig. 2. Temperature anomalies aggregated over the shelf volume of 'locked' waters (as defined by σ_θ=14.2) and averaged over summer months (May-November) shown as function of time + 5yr running mean. Error bars = 1 standard deviation.

References
1 - Özsoy E. and Ünlüata U., 1997. Oceanography of the Black Sea: a review of some recent results. *Earth-Sci. Rev.*, 42: 231-272
2 - Ivanov L.I., Backhaus J.O., Özsoy E. and Wehde H. ,2001. Convection in the Black Sea during cold winters. *J. Marine Syst.* , 31: 65-76
3 - Tugrul S., 1993. Comparison of TOC concentrations by persulphate–UV and high-temperature catalytic oxidation techniques in the Marmara and Black Seas. *Mar. Chem.*, 41: 265–270

SEA SURFACE TEMPERATURE AND CHLOROPHYLL NON-SEASONAL VARIABILITY IN THE AEGEAN SEA BY MEANS OF EOF ANALYSIS OF SATELLITE DATA

N. Skliris [1]*, A. Mantziafou [1], S. Sofianos [1], A. Gkanasos [1] and A. Lascaratos [1]

[1] University of Athens, Ocean Physics and Modelling Group, Bld. Phys-V, Athens 15784, Greece - nskliris@oc.phys.uoa.gr

Abstract

Empirical Orthogonal Function (EOF) analysis is applied to 8-day composite AVHRR-derived Sea Surface Temperature (SST) and SeaWiFS-derived surface chlorophyll (Chl) data (1998-2005) to study the variability of the two parameters in the Aegean Sea from sub-seasonal to interannual time-scales. Results indicate low SST non-seasonal variability, which is controlled by synoptic weather variations and anomalies in the north-south wind-stress component. On the other hand, variations in the Dardanelles chlorophyll inflow and in the riverine nutrient inputs regulate the large intra-annual and interannual variability of Chl.

Keywords: Aegean Sea, Temperature, Chlorophyll-a, Dardanelles

Introduction

The Aegean Sea displays prominent hydrodynamic features involving all time/space scales such as strong baroclinic and topography-induced currents, upwelling regions and frontal zones with important implications on the dynamics of plankton ecosystems. Although the region is often considered to be an oligotrophic environment large gradients of primary productivity have been observed and the highly productive areas are mainly located in the northern basin [1]. In the present study eight years of satellite-measured SST and Chl are analysed in order to capture the dominant space/time features of the Aegean Sea surface variability.

Method

Daily global SeaWiFS ocean colour data (1998-2005) with 1/12° spatial resolution available from the Distributed Active Archive Center at the NASA Goddard Space Flight Center are used. In order to convert ocean colour to chlorophyll-a concentration, all the available SeaWiFS data of the raw measured wavelength bands are re-processed with the MedOC4 bio-optical algorithm, built specifically for the Mediterranean Sea [2]. The construction of SST maps is based on a re-analysis of AVHRR Oceans Pathfinder SST timeseries of the Mediterranean Sea at a 1/16° resolution-grid [3]. EOF analysis (i.e. based on the Singular Value Decomposition method) is applied to the 8-day anomaly time series of the two datasets (i.e. the total harmonic seasonal cycle is removed from the original time series) to study the non-seasonal (intra-annual and interannual) variability of the two parameters.

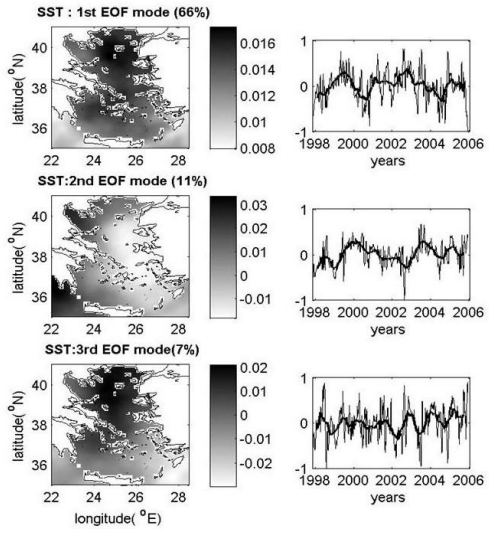


Fig. 1. EOF decomposition of the SST anomaly dataset. Spatial amplitudes (left panels) and temporal modes (right panels). The variance explained by each EOF mode is also depicted. The 22-point (176-day) running mean (dark lines) suppresses signals with timescales less than a year and represents interannual variability.

Results and discussion

Data analysis shows that non-seasonal signals account for the largest part of the Chl total variance (~70%), whereas SST variability is overwhelmed by the seasonal cycle (~98%). EOF results for the SST anomalies (Fig. 1) indicate that non-seasonal variability is induced by synoptic atmospheric weather variations (1st EOF) and anomalies in the north-south wind-stress component mainly occurring during the summer upwelling regime (2nd EOF and 3rd EOF).

EOF analysis of Chl anomalies (Fig. 2) shows large intra-annual variability and clear interannual signals, associated with much larger production during the bloom periods of specific years (i.e. in 1999 and 2004). Results indicate that Chl non-seasonal variability is mainly controlled by variations in the Dardanelles chlorophyll outflow (1st EOF and 3rd EOF), in the position of the hydrological front and the Samothraki anticyclone (2nd EOF), and in the riverine nutrient inputs within the North Aegean Sea. EOF and correlational analysis of the anomaly time-series demonstrate that non-seasonal variations of the two parameters are much less linked than in the global ocean, implying that mixing and upwelling processes play a minor role in controlling surface chlorophyll variability in the Aegean Sea.

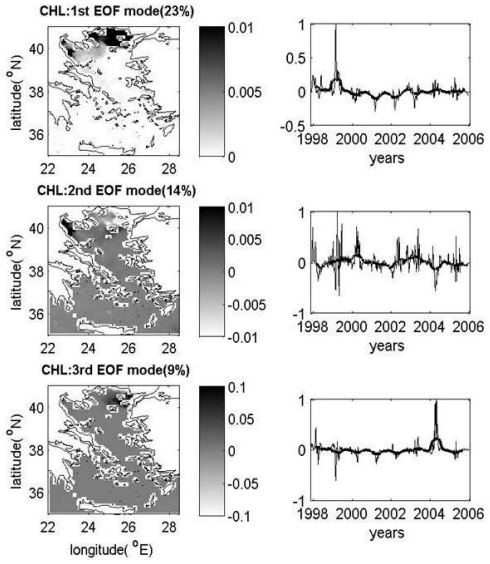


Fig. 2. Same as Fig.1 but for the Chl anomaly dataset.

References

1 - Ignatiades, L., Psarra, S., Zervakis, V., Pagou, K., Souvermezoglou, E., Assimakopoulou, G., Gotsis-Skretas, O., 2002. Phytoplankton size-based dynamics in the Aegean Sea (Eastern Mediterranean). *J. Mar. Syst.*, 36: 11-28.

2 - Marullo S., Buongiorno Nardelli, B., Guarracino, M., Santoleri, R., 2006. Observing the Mediterranean Sea from space: 21 years of Pathfinder-AVHRR Sea Surface Temperatures (1985 to 2005). Re-analysis and validation. *Ocean Sci.*, 3: 299-310.

3 - Volpe G., Santoleri R., Vellucci V., Ribera d'Alcalà, M., Marullo, S., D'Ortenzio, F., 2006. The colour of the Mediterranean Sea: global versus regional bio-optical algorithms evaluation and implication for satellite chlorophyll estimates. *Rem. Sens. Envir.*, 81: 163-178.

REAL TIME REGIONAL FORECASTING SYSTEM INTO THE SICILY CHANNEL

Roberto Sorgente [1]*, Antonio Olita [1], Leopoldo Fazioli [1] and Alberto Ribotti [1]
[1] CNR-IAMC U.O.S. di Oristano, Loc. Sa Mardini, Torregrande (OR), Italy - roberto.sorgente@cnr.it

Abstract
Real time short-term forecasts of the circulation in the Sicily Channel are operationally produced and their accuracy against satellite sea surface temperature fields is evaluated from August 20th to October 20th 2009 on a daily basis. This analysis allowed us to assess the skill of the present ocean forecasting system.
Keywords: Models, Circulation, Straits And Channels, Sicilian Channel

The Forecasting System
The Sicilian Channel Regional Model Forecasting System (SCRMFS) is based on a nested eddy resolving numerical model implemented in the Sicily Channel area. It is driven at the surface by the hourly forcing from the Limited Area Model ETA/SKIRON atmospheric forecast fields with a horizontal resolution of 10 km [1]. The atmospheric forcing parameters include: mean sea level pressure, air temperature at 2 m, wind speed and direction at 10 m, convective and accumulated precipitation and cloud cover. The net short-wave radiation flux and the downward long-wave radiation flux at the sea surface are provided directly by the weather prediction model at 1-hour interval, while latent and sensible heat fluxes are given by the bulk aerodynamic formulae. Surface momentum fluxes are calculated using the computed drag coefficient of Hellerman and Rosenstein [2]. At the open boundaries, the SCRMFS is nested with the coarse model MFS1671 [3] through an off-line one way nesting technique of the forecasted daily mean fields of temperature, salinity and total velocity. This method was found to be computationally efficient and sufficiently robust to transmit information across the lateral boundaries without excessive distortion [4]. The SCRMFS is initialized daily in slave mode, then through the downscaling and optimization of coarse resolution forecast fields (temperature, salinity and current velocity) using the Variational Initialization method, named VIFOP [5]. It allows to reduce the high frequency oscillations during the initial conditions (spin-up time) [6]. SCRMFS produces daily 5-day forecast, in slave mode, providing detailed information on the mesoscale and sub-mesoscale components that cannot be resolved by the coarse resolution model. The performance of SCRMFS depends on the accuracy of the hourly surface wind stress and heat fluxes provided by SKIRON, but in a slave mode forecast the quality of the initial conditions derived from the downscaling of the first forecasted day of the coarse resolution model is even more critical.

The validation
The dataset used for the online validation is the daily NRT Optimally Interpolated Sea Surface Temperature (OISST), obtained from the AVHRR (Advanced Very High Resolution Radiometer) night-time data acquired and processed at ISAC-GOS of CNR. The level of agreement between the forecast and the truth (assumed to be given by the satellite observation) is computed using basic statistics, such as the correspondence between the mean forecast and mean observation (BIAS), the root mean square error (RMSE), the standard deviation (σ) and the Sea Surface Temperature Skill Score (SSTSS).

Results
The daily averaged scores have been computed for each forecast cycle over the period 20 August – 20 October 2009, in agreement with the largest horizontal temperature gradients due to the warm waters over shelf areas and the well-known upwelling along the south of Sicily, induced by the Atlantic Ionian Stream and its summer features. Between the fifth and last forecast cycle (Fig.1, top), the RMSE estimates a range approximately from 0.9°C to 0.6°C, while the standard deviation presents higher values. Then the SSTSS increases from 0 °C to 0.4 °C (Fig. 1, bottom). This means that the last forecast cycle (24 hours before) is about 40% better than the fifth (120 hours before). The averaged biases for the five cycles range from 0.16 °C of the first cycle to -0.05 °C of the fifth, with a clear negative trend. So the model is on average warmer the first 3 and colder the last 2 forecast days than the observations

Conclusions
The performance of SCRMFS against satellite SST has been evaluated by means of standard statistics. Notwithstanding the use of only satellite observations for a short period in time, this preliminary assessment of the forecasting system shows a reasonable performance in comparison to other forecast numerical models available from the bibliography [7] which, in slave mode, are greatly dependent on the accuracy of the coarse resolution model furnishing the initial conditions.

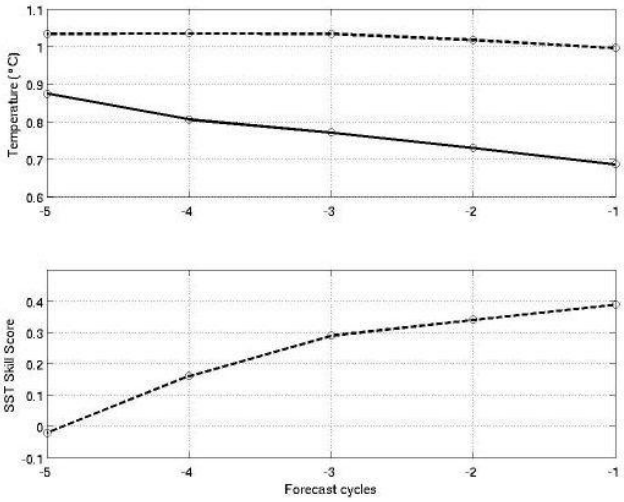


Fig. 1. Top: Standard deviation (dashed line) of the model SST field and RMSE (continuous line) between model and satellite SST, averaged for each forecast cycle; Bottom: Skill Score averaged for each forecast cycle.

References
1 - Kallos G., Nickovic S., Papadopoulos A., Jovic D., Kakaliagou O., Misirlis N., Boukas L., Mimikou N., Sakellaridis G., Papageorgiou J., Anadranistakis E. and Manousakis M., 1997. The regional weather forecasting system SKIRON: An overview, paper presented at the International Symposium on Regional Weather Prediction on Parallel Computer Environments, University of Athens, Athens, Greece, 15-17 October 1997.
2 - Hellerman S. and Rosenstein M., 1983. Normal monthly wind stress over the world ocean with error estimates. *J. Phys. Oceanog.*, 13: 1093-1104.
3 - Pinardi N., Allen I., De Mey P., Korres G., Lascaratos A., Le Traon P. Y., Maillard C., Manzella G. and Tziavos C., 2003. The Mediterranean ocean Forecasting System: first phase of implementation (1998-2001). *Ann. Geophys.*, 21: 1, 3-20.
4 - Sorgente R., Drago A.F. and Ribotti A., 2003. Seasonal variability in the Central Mediterranean Sea circulation. *Ann. Geophys.*, 21: 299-322.
5 - Auclair F., Casitas S. and Marsaleix P., 2000. Application of an Inverse Method to Coastal Modeling. *J. Atmos. Ocean. Technol.*, 17: 1368–1391.
6 - Gaberšek S., Sorgente R., Natale S., Ribotti A., Olita A., Astraldi M. and Borghini. M., 2007. The Sicily Channel Regional Model forecasting system: initial boundary conditions sensitivity and case study evaluation. *Ocean Sci.*, 3: 31-41.
7 - Chiggiato J. and Oddo P., 2008. Operational ocean models in the Adriatic Sea: a skill assessment. *Ocean Sci.*, 4: 61-71.

ESTIMATION OF THE ATLANTIC INFLOW THROUGH THE STRAIT OF GIBRALTAR FROM CLIMATOLOGICAL AND IN SITU ADCP DATA

J. Soto-Navarro [1]*, F. Criado-Aldeanueva [1], J. García-Lafuente [1], A. Sánchez-Román [1] and C. Naranjo-Rosa [1]
[1] Physical Oceanography Group, University of Málaga, Málaga, Spain - javiersoto@uma.es

Abstract
A combined reanalysis, satellite and experimental dataset has been used to calculate a four-year time series of the Atlantic inflow through the Strait of Gibraltar. An indirect estimation of the net flow through the strait from the hydrological cycle has been combined with direct Mediterranean outflow measurements, collected in the Espartel sill (western Strait of Gibraltar), resulting a mean inflow of 0.814 Sv with a seasonal cycle of 0.026 Sv amplitude peaking in September. Two possible forcing mechanisms are suggested for this cycle: a main barotropic one, related to the ocean-atmosphere water deficit and a secondary baroclinic one related to the hydrological conditions in the strait.
Keywords: Strait Of Gibraltar, Water Transport, Air-Sea Interactions, Hydrology, Sea Level

The importance of the exchange through the Strait of Gibraltar for the Mediterranean termohaline circulation and hence for the entire Mediterranean climate is well known. Several works have studied this exchange, most of them focusing on the evaluation of the net flow and the Mediterranean outflow, but only a few of them describe the Atlantic inflow. The latter are based on experimental measurements of about two-year long time series [1, 2, 3]. In this work we make an indirect estimation, climatologically and experimentally based, of a four-year long time series.

$$\frac{dM}{dt} = S\frac{d\xi_M}{dt} = P - E + R + B + G$$

Eq.1 describes the mass budget in the Mediterranean Sea that is used to calculate the net flow, where the left-hand side, dM/dt , is the mass time-variation, S the Mediterranean surface and ξ_M the mass-induced sea level anomaly. The rigth-hand side terms are the different contributions to the budget: precipitation, P, evaporation, E, river discharge, R, the exchange with the Black Sea through the Turkish Straits, B, and the net flow through the Strait of Gibraltar, G. NCEP monthly mean data has been used to evaluate evaporation and precipitation. The mass contribution to the sea level anomaly has been calculated subtracting from AVISO total level the steric contribution computed from the water column salinity and temperature data of the ECCO model dataset. Data of river discharge and exchange with the Black Sea have been obtained from the works of [4] and [5] respectively. Once estimated the net flow, direct ADCP measurements of the outflow collected in the Espartel sill (western Strait of Gibraltar) have been used to calculate the inflow. A mean value of 0.814 Sv, with a seasonal cycle of 0.026 Sv amplitude peaking in September, has been obtained, in good agreement with the previous works [1, 2, 3].

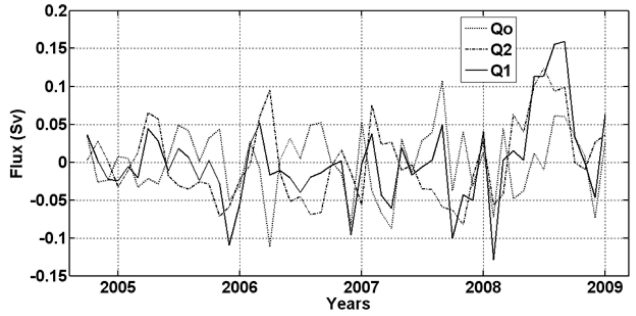


Fig. 1. Inflow (Q_1), outflow (Q_2) and net flow (Q_0) through the Strait of Gibraltar anomalies. The anomalies has been represented for a better visualization of the importance of the seasonality of each component, Q_0 and Q_2 , to the inflow calculation.

Two possible forcing mechanisms have been considered to explain the seasonal cycle of the Atlantic inflow. The first and main one of barotropic nature, related to the ocean-atmosphere water deficit, strongly dependent of E-P, whose seasonal cycle also peaks in September. The second one has baroclinic nature and is related to the hydraulics conditions in the strait, which implies that both the inflow and outflow velocity depends on the square root of their density difference [6]. This means that an increase (decrease) in the outflow (inflow) density produces an increase in both velocities and vice versa. Thus, during summer, when sea surface temperature reaches its maximum, the surface layer density decreases due to the associated volume increase. This feature is also reflected in the maximum of the steric sea level in September [7] and produce an increase in the inflow velocity that contributes to the September peak.

References
1 - Bryden H. L., J. Candela, and T. H. Kinder, 1994. Exchange through the Strait of Gibraltar, *Prog. Oceanog*, 33: 201–248.
2 - Candela J., 2001. Mediterranean water and global circulation. *In* : G. Siedler, J. Church, and J. Gould (ed.). Ocean Circulation and Climate. Academic Press Publ. San Diego, Ca. pp. 419-429.
3 - García Lafuente J., Delgado J., Vargas J.M., Vargas M., Plaza F. and Sarhan T., 2002. Low-frequency variability of the exchanged flows through the Strait of Gibraltar during CANIGO. *Deep Sea Res. II*, 49: 4051– 4067.
4 - Struglia M.V., Mariotti A. and Filograsso A., 2004. River discharge into the Mediterranean Sea: Climatology and aspect of the Observed Variability. *J. Climate*., 17: 4740-4751.
5 - Kanarska Y. and Maderich V., 2008. Modelling of seasonal Exchange flows through the Dardanelles Strait. *Estuarine*,*Estuar. Coast. Shelf Sci*., 79: 449-458.
6 - Armi L. and Farmi D., 1986. The internal hydraulics of the Strait of Gibraltar and asociated sills and narrows. *Oceanol. Acta*., 8: 37-46.
7 - Criado-Aldeanueva F., Del Río Vera J. and García-Lafuente J., 2008. Steric and mass induced sea level trends from 14 years altimetry data. *Glob. Planet. Change*., 60: 563-575.

ABYSSAL HYDROGRAPHIC CONDITIONS IN THE IONIAN SEA FROM 2006 TO 2009

S. Sparnocchia [1]*, G. P. Gasparini [2], K. Schroeder [2], H. Kontoyiannis [3] and M. Borghini [2]
[1] CNR - Istituto di Scienze Marine, section of Trieste, Italy - stefania.sparnocchia@ts.ismar.cnr.it
[2] CNR - Istituto di Scienze Marine, section of La Spezia, Italy
[3] Hellenic Center for Marine Research, Athens, Greece

Abstract

During KM3NeT project, an intense observational activity was conducted in the Ionian Sea, mainly south-east of Capo Passero (Sicily) and off the south-western tip of Peloponissos (Greece). The several oceanographic cruises performed from 2006 to 2009 permitted to describe the current status of the deep layer, together with its recent evolution. While newly formed Adriatic dense water is the principal abyssal signature in the western Ionian, the Cretan water vein fills all the deep layer in the eastern Ionian. These observations confirm that the deep Ionian Sea is undergoing significant changes, especially after the Adriatic Sea has became an active source of dense water again.

Keywords: Deep Waters, Circulation, Ionian Sea

The Ionian Sea collects the dense waters formed in the Eastern Mediterranean in its abyssal plain. The Adriatic Sea was the main source of these waters up to the end of the 80's. After that date, an important climatic variation occurred (the Eastern Mediterranean Transient) which had an impact on the whole Eastern Mediterranean, and a new source started up in the Aegean Sea. The Aegean water was warmer, saltier and denser than the one formed previously in the Adriatic Sea, so it filled the deepest layers of the Ionian [1]. Around 1995 the Aegean source dropped and the Adriatic became an active source again, producing new water whose temperature and salinity were warmer and saltier when compared to the past [2, 3]. The several oceanographic cruises performed in the Ionian Sea from 2006 to 2009 permitted to follow the recent evolution in the abyssal hydrography, and provided some insight into their variability.

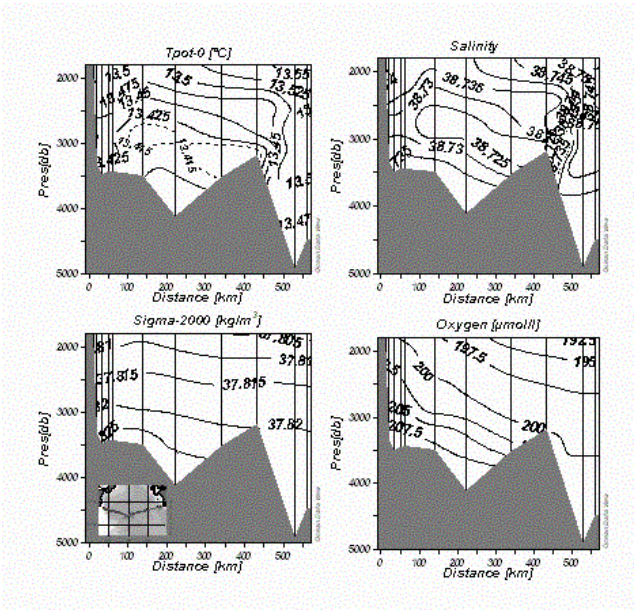


Fig. 1. Vertical section of potential temperature (°C), salinity, density (σ2 units), dissolved oxygen content (µmol/l) in July 2007 between 1500 m depth and the bottom.

In July 2007, a hydrographic section covered the central Ionian basin from Sicily to Greece almost synoptically (Fig. 1), giving a nearly complete zonal view of the abyssal layer. The physical-chemical properties from 1800 m to the bottom show distinct water masses, with significant differences both in temperature and salinity. A clear gradient can be observed in correspondence to the meridional ridge which separates the central and the eastern deeps. On the western side, below 2000 m, a marked stratification is found with warmer and saltier water superimposed on a fresher and colder layer. Both the layers extend their influence upto the central abyssal plain. The two water types are probably of Adriatic origin, but the higher oxygen content close to the bottom suggests that the most recent Adriatic water is warmer and saltier than before. On the eastern side, higher salt content and higher temperature evidence the presence of Cretan water in the deep column, mainly concentrated between 2000 and 3000 m of depth.

A comparison between observations off Sicily from different periods evidenced a certain water mass variability: an almost homogeneous stratification below 2500 m is sometimes replaced by a situation characterized by the presence of several water masses, identified by closed structures. Current measurements, acquired from May 2007 to May 2009 at 3000 m of depth near the Maltese shelf break and about 20 miles eastward, evidence the prevalence of a southward flow at the first site and a north-westward one at the second, while the oscillations of the two currents are inversely correlated. This suggests a circulation frequently organized along a cyclonic pattern, as indicated by the closed structures observed from the hydrography. More energetic currents are found close to the shelf break, and a pronounced variability is observed at both the sites, on the seasonal and the interannual time scales.

These results depict a variable cyclonic abyssal circulation that is more energetic when compared to previous measurements collected in the same area. The increased activity has probable links with the new Adriatic dense water flowing into the region.

Acknowledgement: The data presented were acquired within the framework of the "Specific Support Action for the Design Study for a Deep-Sea Facility in the Mediterranean for Neutrino Astronomy and Associated Sciences" (KM3NET), EU contract number 011937.

References

1 - Roether W., Manca B. B., Klein B., Bregant D., Georgopoulos D., Beitzel V., Kovacevic V. and Luchetta A., 1996. Recent changes in the Eastern Mediterranean Deep Water, *Science*, 271: 333-335.

2 - Theocharis A., Klein B., Nittis K. and Roether W., 2002. Evolution and status of the Eastern Mediterranean Transient (1997-1999). *J. Mar. Syst*., 33-34: 91-116, doi: 10.1016/S0924-7963(02)00054-4.

3 - Manca B.B., Budillon G., Scarazzato P. and Ursella L., 2003. Evolution of dynamics in the eastern Mediterranean affecting water mass structures and properties in the Ionian and Adriatic Seas. *J. Geophys. Res*., 108 (C9), 8102, doi:10.1029/2002JC001664.

TOWARDS LONG-TERM FORECAST OF THE NORTHERN ADRIATIC WINTER CONDITIONS

N. Supic [1]*, R. Kraus [1], M. Kuzmic [2], E. Paschini [3], R. Precali [2] and A. Russo [4]
[1] Center for Marine Research, Ruder Boškovic Institute, Rovinj, Croatia - supic@cim.irb.hr
[2] Center for Marine and Environmental Research, Ruder Boškovic Institute, Bijenicka cesta 54, Zagreb, Croatia
[3] CNR - Institute of Marine Sciences, Section of Ancona, L.go Fiera della Pesca, 1 Ancona, I-60135, Italy,
[4] Department of Marine Sciences, Polytechnic University of Marche, Via Brecce Bianche, Ancona, I-60131, Italy,

Abstract
Winter geostrophic circulation patterns in 2000 and 2001 in the northern Adriatic, as a result of bottom density distribution, were different. Formed earlier in autumn under different atmospheric forcing, they remained stable even in conditions of above average surface heat losses. This suggests that forecast of the northern Adriatic geostrophic circulation patterns is attainable several months in advance.
Keywords: Adriatic Sea, Circulation

Introduction
The northern Adriatic is influenced by the Po River, one of the largest in the Mediterranean basin. In winters termed as type A, bottom density is higher in the eastern than in western part of the northern Adriatic, while for winters of type B the situation is opposite (1). The Po River waters more likely spread across the northern Adriatic in winters of the type A (in preparation). As a consequence, large phytoplankton production in the entire northern Adriatic is expected to occur in A winter types, whereas dense water formation characterizes the B ones. In this work winter oceanographic conditions of type A and type B, for 2001 and 2000 respectively, were analyzed.

Data and methods
Data collected during six large oceanographic cruises at three transects (45 stations; Fig. 1) in the northern Adriatic were used to plot distributions of temperature, salinity, density and geostrophic currents relative to 30 dbar surface (Oct 1999, Jan 2000, Feb 2000, Oct 2000, Dec 2000, and Feb 2001). Daily values of meteorological data and surface fluxes in the region, as well as the Po River flows were also analyzed for the periods Oct 1999 - Feb 2000 and Oct 2000 - Feb 2001.

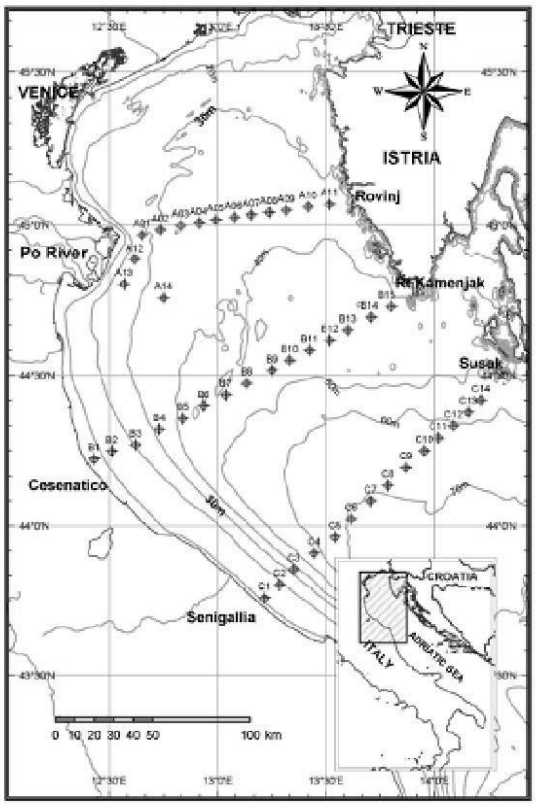


Fig. 1. Map of the northern Adriatic with position of stations

Results
Winter geostrophic circulation patterns in both 2000 and 2001 remained stable between the two subsequent cruises (Jan and Feb 2000; Dec 2000 and Feb 2001). In the winter of 2000 there was a cyclonic gyre off the Po River delta while in the winter of 2001 in the same area an anticyclonic gyre was present (Fig. 2). The differences in circulation patterns were due to differences in bottom density distribution (Fig. 2). Monthly values of northern Adriatic surface heat losses for both Jan 2000 and 2001 were above their long-term means (not shown). Bottom density fields were already formed in late autumn, starting from October (not shown). The autumn of 1999 was characterized by many bora episodes and very large surface heat losses while in 2000 by strong sirocco events and moderate surface heat fluxes.

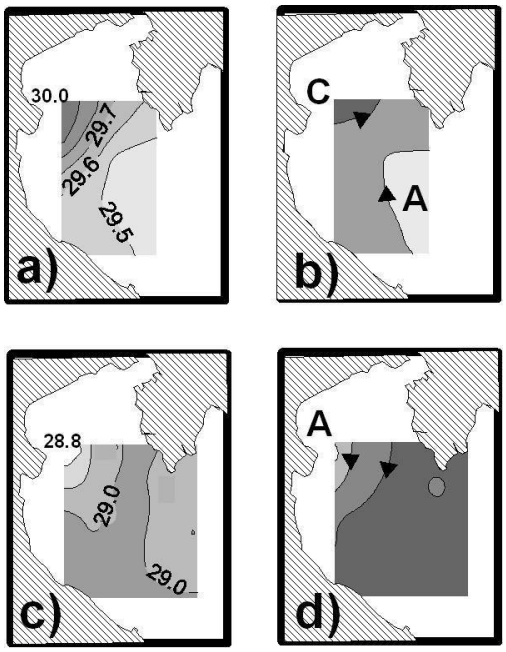


Fig. 2. Distribution of bottom density and of surface geostrophic currents relative to the 30 dbar surface in February 2000 (a and b) and February 2001 (c and d). A and C represent anticyclonic and cyclonic sense of rotation, respectively

Conclusion
The results strongly support the hypothesis that autumn conditions determine the next winter geostrophic circulation patterns, allowing us to forecast the northern Adriatic winter hydrographic conditions.

References
1 - Supic N. and Vilibic I., 2006. Dense water characteristics in the northern Adriatic in the 1967-2000 interval with respect to surface fluxes and Po River discharge rates. *Estuar. Coast. Shelf. S.*, 66: 580-593.

THE SURFACE CIRCULATION IN THE EASTERN BASIN OF THE MEDITERRANEAN AND THE IMPACT OF THE MESOSCALE EDDIES.

I. Taupier-Letage [1]*, C. Millot [1], J. Fuda [1], G. Rougier [1], R. Gerin [2], P. Poulain [2], R. Pennel [3], K. Beranger [3], M. Emelianov [4], J. Font [4], S. Ben Ismail [5] and C. Sammari [5]

[1] CNRS/Université de la Méditerranée/COM, Toulon, France - isabelle.taupier.letage@ifremer.fr

[2] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy

[3] Ecole Nationale Supérieure des Techniques Avancées Paris Tech - UME, Palaiseau, France

[4] Institut de Ciències del Mar CSIC, Barcelona, Spain

[5] Institut National des Sciences et Technologies de la Mer, Salammbô, Tunisia

Abstract

The EGYPT (Eddies and GYres Paths Tracking) - EGITTO program data sets provide an unprecedented insight into the Eastern Basin surface circulation. They confirmed the Atlantic Water (AW) path be an anticlockwise circuit along the basin slopes, and its frequent offshore dispatching related to the paddle-wheel effect of the mesoscale eddies generated by the southern part of the circuit, the Libyo-Egyptian Current. However, in opposition with earlier observations, several eddies have been tracked drifting westward for several months, up to one year. The study of the circulation in the Eastern Basin remains a challenge yet.

Keywords: Eastern Mediterranean, Circulation

Our knowledge and understanding of the circulation in the Eastern basin have yet to be improved. The EGYPT/EGITTO program (2005-2007) was a main effort to acquire in situ observations in the Eastern Basin, with a focus on its southern part that has been little sampled up to now. Platforms included a 1-year 7-mooring array, a network of 125 CTD casts, ~ 200 XBTs, ~100 surface drifters, ~15 Argo profilers, and the continuous coverage with thermal satellite images to allow for targeted sampling [1]. In the south the circulation of the Atlantic Water (AW) has been clearly shown anticlockwise and alongslope [2, 3], in agreement with numerical simulations [4]. However the corresponding distribution of the lower salinities most often appear complex, that is highly variable in space and time. Indeed the Libyo-Egyptian Current (LEC) is unstable, and generates mesoscale (anticyclonic) Libyo-Egyptian Eddies (LEEs) [5]. The numerous interactions between the LEC and one or more LEEs induce a paddle-wheel effect, that dispatch AW first offshore and then around the LEEs [6]. That was shown during the EGYPT-1 campaign: on the CTD transect from the Libyan shelf to the Greek slope (figure 1), the minimum of salinity was found on the northern edge of the eddy LE. Another LEE, downstream LE and south of the wind-induced Ierapetra eddy (I-2005, figure 1), also concurred to dispatch AW on the eastern edge of I-2005 (see the corresponding drifters trajectories on fig.5k of [3]). The figure 2 illustrates this paddle-wheel effect: AW is indeed transported offshore eastward, but on the successive edges of LEEs: there is no such permanent path as the so-called "Mid-Mediterranean Jet" (MMJ). Now, because LEEs can remain motionless, drift, and/or interact with neighbouring ones for several months, they have a significant weight in statistics that can lead to artefacts. This is the case for instance of the Lagrangian statistics on the drifters trajectories, of which the mean displays a strong jet offshore Libya. When this evokes a MMJ, it is actually the northern edge of a LEE [7].

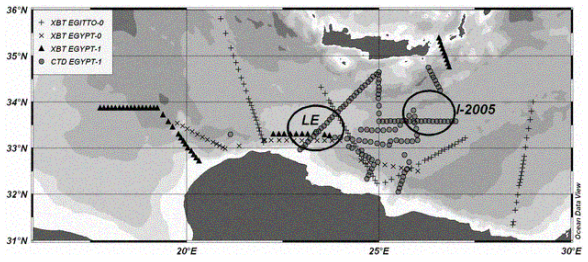


Fig. 1. Sampling during the EGYPT-EGITTO program, with the main eddies indicated for Spring 2006.

These LEEs, and Ierapetra as well, can actually perturb the circulation down to the bottom (~3000m), as shown by the deeper currentmeters [8]. Now, contrary to the general eastward drift observed during 4 years on the period 1996-2000 (over 1000 IR images analysed [9]), in 2006 3 LEEs drifted westward alongslope for months, one for more than 1 year [8]. One hypothesis put forward is the abrupt change of the steepness of the slope [10]. But such a change occurs only for in eddy (LEE1) off Libya at 24°E. Additional analyses are thus required. The study of the Eastern Basin circulation might be more difficult than that of the Western Basin: while the weight of the mesoscale dynamics and the variability it induces imply to acquire additional such high resolution synoptic surveys, rising problems to gain authorizations for sampling are most likely to keep their number low. The Eastern Basin is likely to remain a challenge for some time.

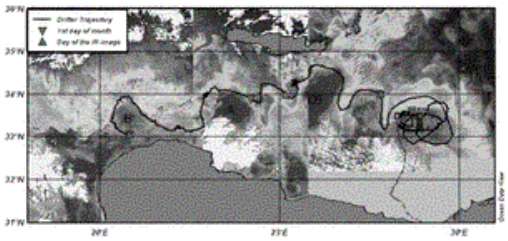


Fig. 2. Trajectory of a surface drifter from February to May 2006.

References

1 - Taupier-Letage I. and the EGYPT/EGITTO group, 2007. New elements on the surface circulation in the eastern basin of the Mediterranean. *Rapp. Comm. Int. Mer Medit.*, 38: 204

2 - Hamad N., Millot C. and Taupier-Letage I., 2005. A new hypothesis about the surface circulation in the eastern basin of the Mediterranean sea. *Prog. Oceanogr.*, 66: 287-298.

3 - Gerin R., Poulain P-M., Taupier-Letage I., Millot C., Ben Ismail S. and Sammari C., 2009. Surface circulation in the Eastern Mediterranean using drifters (2005-2007). *Ocean Sci.*, 5: 559–574.

4 - Alhammoud B., Béranger K., Mortier L., Crépon M. and Dekeyser I., 2005. Surface circulation of the Levantine Basin : comparison of model results with observations. *Prog. Oceanogr.*, 66: 299-320.

5 - Millot, C. and Taupier-Letage I., 2005. Circulation in the Mediterranean Sea. *In*: The Handbook of Environmental Chemistry, Vol. K: 29-66. DOI: 10.1007/b107143.

6 - Taupier-Letage, I., 2008. On the use of thermal infrared images for circulation studies: applications to the eastern Mediterranean basin, *In*: Remote sensing of the European Seas, Barale V. and Gade M. eds., Springer Netherlands, 153–164.

7 - Poulain P.-M., Gerin R., Menna M., Taupier-Letage I., Millot C., Ben Ismail S., Sammari C., Zodiatis G. and Gertman I., 2010. A Lagrangian view of the Eastern Mediterranean surface circulation over the last two decades. *In*: CIESM Congress 2010, this issue.

8 - Taupier-Letage I. and Millot C., 2010. Intermediate and deep circulations in the Eastern Basin: focus on its central part from the EGYPT observations (2005-2007). *In:* CIESM Congress 2010, this issue.

9 - Hamad N., Millot, C. and Taupier-Letage I., 2006. The surface circulation in the eastern basin of the Mediterranean Sea. *Sci. Mar.*, 70 (3): 457-503.

10 - Sutyrin G.G., A. Stegner, I. Taupier-Letage and S. Teinturier, 2009. Amplification of a surface-intensifed eddy drift along steep shelf in the eastern Mediterranean sea. *J. Phys. Oceanogr.*, doi: 10.1175/2009JPO4106.1.

INTERMEDIATE AND DEEP CIRCULATIONS IN THE EASTERN BASIN OF THE MEDITERRANEAN: FOCUS ON ITS CENTRAL PART FROM THE EGYPT OBSERVATIONS (2005-2007)

Isabelle Taupier-Letage [1]* and Claude Millot [1]
[1] CNRS/Université de la Méditerranée/COM, Toulon, France - Isabelle.Taupier.Letage@ifremer.fr

Abstract
The Eddies and GYres Paths Tracking (EGYPT, 2005-2007) program was an unprecedented effort to acquire observations in the Eastern Basin, both in situ and remotely sensed. The intermediate and deep circulations between Crete, Libya and Egypt are studied here using mainly the time series of a one-year array of 7 moorings equipped with 30 currentmeters and 10 hydrological probes, and the dense network of 125 CTD casts (10-20km-spaced) realised during the EGYPT-1 campaign (April 2006).
Keywords: Circulation, Eastern Mediterranean, Mesoscale Phenomena

The similarity of the surface circulation patterns between the Western and Eastern Basins prompted original ideas [1]: following our previous work in the Algerian subbasin, in order to improve our knowledge and understanding of the circulation in the Eastern Basin, we conducted the program EGYPT, with the major aim to monitor the path of the Atlantic Water (AW) -with a focus on the Libyo-Egyptian Current (LEC)-, and the Mediterranean Waters (MWs) [2, 3, 4]. We collected current time series with a network of 7 moorings, ~70km spaced, equipped with 5 to 6 currentmeters and hydrological probes from surface (~60m) to the bottom. We initially planned to deploy the moorings off Egypt, since there is no shelf and we could have easily sampled most of the AW flow when alongslope, but we were finally not allowed to do so. The moorings had to be moved off Libya, with two main drawbacks: they were further offshore due to the shelf (over which the AW flows for a great part), and the bathymetry is complex. And finally the upper part of 4 out of 7 moorings went adrift after fish bites, which prompted their anticipated recovery after one year (April 2006 - March 2007), instead of the planned 2-year duration. But the dense CTD network of 125 casts (one out of two down to the bottom) realized during the EGYPT-1 cruise (April 2006) allowed a dense sampling (10-20 km spaced) at subbasin-scale, including the southern shelf and south of Crete. The other observations acquired, among which satellite thermal images, drifters and ARGO profilers, have been listed in [5].

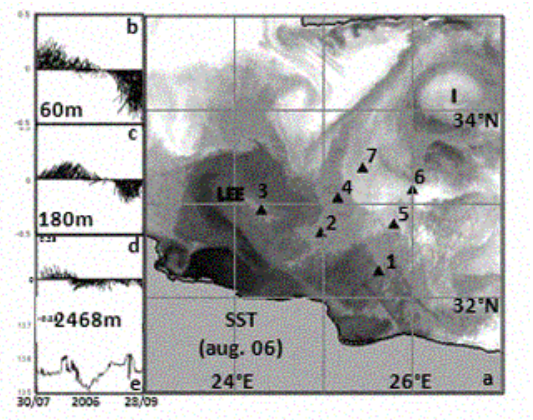


Fig. 1. The passage of a LEE (from east to west) over the mooring 3 during summer 2006, showing the associated anticyclonic currents down to the bottom. a) SST image from mid-August 2006 showing the LEE and Ierapetra (I), EGYPT moorings network (triangles), b-e) records at mooring 3 of current in b) surface, c) intermediate (scale +/- 0.5m/s) and d) bottom layer (scale +/- 0.25m/s), and of e) potential temperature in the bottom layer (scale 13.5-13.7° C).

As expected [2], between Libya, Egypt and Crete the intermediate and deep MWs circulate anticlockwise and alongslope, when not disturbed by mesoscale eddies generated by either the LEC (the Libyo-Egyptian Eddies: LEEs) or the wind (as Ierapetra). We specify the main pathways of the MWs known to form in the Adriatic, the Aegean and the Levantine subbasins, and evidence unreported intermediate water from the Adriatic. As expected from our understanding of the Western Basin functioning, waters at depths 500-1500m are relatively old, so that they are more homogeneous and their circulation is generally weaker than below. At depth (> 3000m), the circulation is markedly influenced by the complex bathymetry, as well as possibly by eddies such as Ierapetra and LEEs, which we show can extend that deep (figure 1). The deeper currents display a high variability in both direction and velocity, with peaks up to 40cm/s a few metres above the bottom. The deepest T and S display variations over ranges of 0.05°C and 0.01, up to ~0.10°C and 0.02 during few-day episodes (figure 1e). Such a high variability is obviously due to the heterogeneity of the deep waters formed far to the north. It is thus clear that deep waters encounter little mixing while spreading and circulating from their formation areas.

A consequence is that the climatological data bases, necessarily based on (historical) sparse data in both time and space, are to be used with extreme caution when it comes to deducing water pathways (cf the LIW path problem when applying unattended statistics on Algerian subbasin data sets [6]), or any climatological signal [7]. In this context, the EGYPT data set can be regarded as a snapshot of reference for 2006-2007. Correlatively, given the natural variability of AW [8] or MWs [9] in the whole Mediterranean Sea, all riparian countries should foster the regular monitoring at basin scale, using not only moorings and thermosalinometers on merchant lines (e.g.Hydrochanges and Transmed CIESM programs, resp.), but also yearly CTD cross-basin transects, an effort sustained for few years now by Italian colleagues in the Western Basin [10].

References
1 - Millot, C. and I. Taupier-Letage, 2005. Circulation in the Mediterranean Sea. The Handbook of Environmental Chemistry, Vol. K: 29-66. DOI: 10.1007/b107143.
2 - Hamad, N., C. Millot, and I.Taupier-Letage, 2005. A new hypothesis about the surface circulation in the eastern basin of the Mediterranean sea. *Progr. Oceanogr.*, 66, 287-298.
3 - Poulain P.-M., R. Gerin, M. Menna, I. Taupier-Letage, C. Millot, S. Ben Ismail, S. Sammari, G. Zodiatis and I. Gertman, 2010. A Lagrangian view of the Eastern Mediterranean surface circulation over the last two decades. CIESM Congress 2010, this issue.
4 - CIESM, 2009. Dynamics of Mediterranean deep waters. N°38 in *CIESM Workshop Monographs* [F. Briand, Ed.], 132 p, Monaco.
5 - Taupier-Letage I. and the EGYPT/EGITTO group, 2007. New elements on the surface circulation in the eastern basin of the Mediterranean. *Rapp. Comm. Int. Mer Medit.*, 38: 204.
6 - Millot C. and I.Taupier-Letage, 2005. Additional evidence of LIW entrainment across the Algerian Basin by mesoscale eddies and not by a permanent westward-flowing vein. *Progr. Oceanogr.*, 66, 231-250.
7 - Vargas-Yáñez M, F. Moya, E. Tel, M. C. García-Martínez, E. Guerber and M. Bourgeon, 2009. Warming and salting in the western Mediterranean during the second half of the 20th century: inconsistencies, unknowns and the effect of data processing. *SCI. MAR.*, 73(1) : 7-28.
8 - MillotC.,2007. Interannual salinification of the Mediterranean inflow. *Geophys. Res. Lett.*, 34, L21609, doi:10.1029/2007GL031179.
9 - Millot C., 2009. Another description of the Mediterranean outflow. *Progr. In Oceanogr.*, 82(2): 101-124.
10 - Schröder K., G-P. Gasparini, M. Borghini and A. Ribotti, 2009. Experimental evidence of recent abrupt changes in the deep Western Mediterranean Sea. in *CIESM Workshop Monographs* 38, [F. Briand, Ed.], Monaco, 51-56.

CURRENT OBSERVATIONS IN THE BOSPHORUS STRAIT DURING EPOS

W. Teague [1]*, E. Jarosz [1], J. Book [1], S. Besiktepe [2], M. Hulbert [1] and A. Quaid [1]
[1] Naval Research Laboratory, Stennis Space Center, MS, USA - teague@nrlssc.navy.mil
[2] NATO Undersea Research Centre, La Spezia, Italy

Abstract

Pairs of acoustic Doppler current profilers (ADCPs) were deployed at each end of the Bosphorus and Dardanelles Straits as part of the United States Naval Research Laboratory's Exchange Processes in Ocean Straits (EPOS) project. All 8 current moorings were deployed in September 2008 and remained in place for about half a year in the Bosphorus and for one year in the Dardanelles. This is the first time that comprehensive current measurements coincident to both straits over seasonal time scales have been made. An overview of the current structure and variability is given here for the Bosphorus Strait to provide insight into the complexity of the TSS dynamics.

Keywords: Bosphorus, Currents

The Turkish Straits System (TSS; Figure 1) consists of the Bosphorus Strait, Sea of Marmara, and Dardanelles Strait and is the only connection between the Black and Mediterranean Seas [1]. The main objective of EPOS is to understand the synoptic variability of the exchange flows in the TSS by study of the currents, temperature, salinity, and microstructure. In close collaboration with the Turkish Navy Office of Navigation, Hydrography and Oceanography and the NATO Undersea Research Center (NURC), the R/V Alliance was used for the mooring work and data collection. The ADCPs were housed in trawl-resistant moorings referred to as Barnys (Figure 2). The nearly full water-column current profiles are used to describe the vertical current structure and the seasonal variability of the two-layer current system in the straits, with focus here on the Bosphorus Strait.

Considerable differences in average flows, current variability, and layer thicknesses were found. Layer interfaces ranged from about 15 to 40 m depth in the Bosphorus Strait while integral time scales for the along strait current components were 6-9 days and maximum observed currents were 231 cm/s. While largest current speeds were observed in the upper layer at the southern end of the Bosphorus, largest speeds were observed in the lower layer at the northern end of the strait. Greatest range in velocity was at the southern end where the currents ranged from -231 to +115 cm/s. Depth dependent processes dominated and were relatively strong in the Bosphorus. Dynamical processes were very different between the ends of the strait. Numerous current reversals were found in the top layer and interestingly can be predicted from the integrated wind stress. We expect that results from this experiment will enhance our understanding of the dynamics in the TSS and will lead to additional field and modeling efforts.

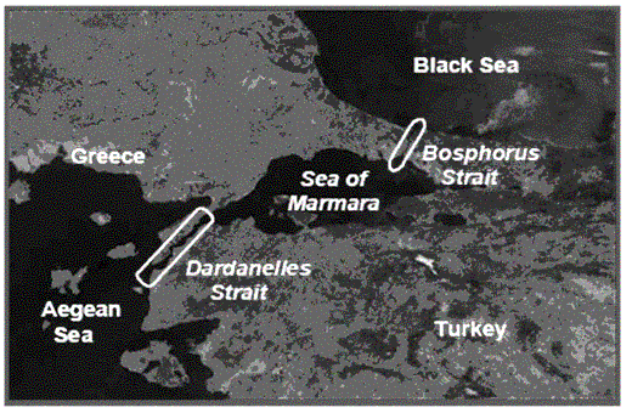


Fig. 1. Turkish Straits System (TSS)



Fig. 2. Shown here is a view of a Barny platform on the sea floor. The ADCP is contained in the Barny and is located at the top. An outer ring of reinforced cement provides impact resistance and ballast. The overall smooth profile minimizes the risk of being fouled by fishing gear and makes the Barny highly resistant to trawling. The entire mooring is recovered at the end of the deployment via acoustic release of a pop-up float that carries a recovery line and the ADCP to the surface.

References

1 - Latif M.A., Özsoy E., Oguz T. and Ünlüata Ü., 1991. Observations of the Mediterranean inflow into the Black Sea. *Deep-Sea Res.*, 38 (Suppl. 2): S711–S723.

TIME-SERIES ANALYSES OF ATMOSPHERIC AND MARINE OBSERVATIONS ALONG THE TURKISH COAST

Ersin Tutsak [1]*, Emin Özsoy [1] and Y. sinan Husrevoglu [1]
[1] Institute of Marine Sciences, METU, Erdemli, Turkey - ersin@ims.metu.edu.tr

Abstract
Time series and spectral analyses are applied to surface atmospheric (wind velocity, air temperature, barometric pressure, relative humidity) and sea level data obtained from monitoring stations along the Turkish coast. Analyses of time series longer than a year identify main time scales of transport and motion while establishing seasonal characteristics, i.e. distinguishing, for instance, between winter storms and summer sea-breeze system. Marine flow data acquired by acoustic doppler current profilers (ADCP) are also analyzed to better understand the response of the dynamics along the Turkish coast to short-term climatic variability. Cumulative results obtained from these analyses determine temporal and spatial scales of coastal atmospheric and marine fluxes of momentum, heat and buoyancy as affected by the regional climate system.
Keywords: Time Series, Sea Level, Air-Sea Interactions

Introduction and Methods
The total of 12 atmospheric and marine coastal monitoring stations along the Turkish coast of the Mediterranean, Aegean, Marmara and Black Seas and the Bosphorus and Dardanelles Straits (Figure 1) traverse approx. 2500 km of coastline with a maximum separation of approx. 800 km. The stations were installed within the framework of the Turkish Meteorology and Oceanography Excellence Network pilot project coordinated by the Institute of Marine Sciences, Middle East Technical University. These automatic data acquisition systems collect surface atmospheric data (air pressure, wind, air temperature, and relative humidity) in addition to sea-level measurements acquired by electronic tide gauges.

The main objective for establishing this coastal monitoring network is to obtain long-term time series of surface atmosphere and ocean data in an attempt to understand and quantify regional climatic variability in the Turkish coastal system as well as the effects of such variability on the Mediterranean-Black Sea coupling through the Turkish Straits System (TSS). The TSS is sensitive to climatic changes and potentially causes such changes in the adjacent basins [1]. The sea level difference over the Bosphorus plays an important role for the overall flow. Sea level is highly variable through the Turkish strait system and is influenced by the Black Sea and the Mediterranean oscillations, but is not affected by the tidal oscillations [2]. Over the Black Sea strong winds can control the water flow of the Bosphorus strait, thus the mean sea level of the Black sea at intra-seasonal frequencies. The Mediterranean water flow into the Black sea can be blocked as the northerly winds blow. Also, sufficiently intense southerlies may cause to cease the upper layer flow from Black Sea [3].

Based on measurements, taken during longer than a year, time series and spectral (auto-, cross-, and rotary spectra) analyses are performed to exhibit the measurements in both time and frequency domains, which enable to detect temporal and spatial scales of phenomena, oscillations and correlations of the observations in distinct areas.

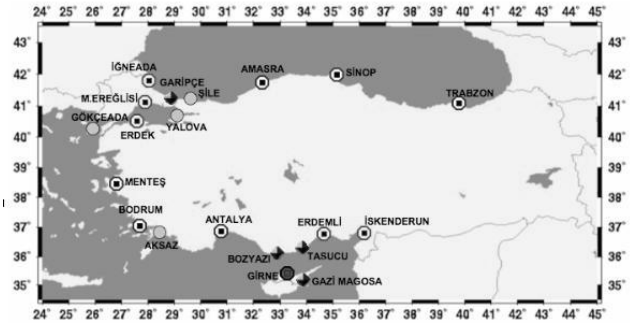


Fig. 1. Coastal observation stations along the Turkish coasts

Results
Spectral analyses of the sea level indicate basin oscillations of several days to weeks in addition to diurnal and semi-diurnal oscillations in sea level forced by the winds, barometric pressure differences and storm surges. Frequently, a sea level difference of about 40 cm is observed between the Black and Marmara Seas, which vanishes during some blockage events of the Bosphorus upper layer.

References
1 - Özsoy E.,1999. Sensitivity to Global Change in temperate Euro-Asian seas (The Mediterranean , Black Sea and Caspian Sea): A review , *In:* P. Malanotte-Rizzoli and V. N. Eremeev (editors), The Eastern Mediterranean as a Laboratory Basin for the Assessment of Contrasting Ecosystems, NATO Science Series 2, Environmental Security,51,Kluwer Academic Publishers, Dordrecht, pp. 281-300.
2 - Alpar B. and Yüce H., 1998. Sea level Variations and their interactions Between the Black Sea and the Agean Sea. *Estuar. Coast. Shelf S.*, 46: 609-619.
3 - Ünlüata Ü., Oguz T,Latif M.A. and Özsoy E.,1990. On the physical oceanography of the Turkish Straits. *In:* Pratt, L.J. (ed.). Kluwer Academic Publishers, Dordrecht ,pp. 25-60.

BUDGET OF BIOGENIC ELEMENTS IN THE NW MEDITERRANEAN OVER THE PERIOD 2004-2008 USING A 3D PHYSICAL-BIOGEOCHEMICAL COUPLED MODEL

C. Ulses [1]*, F. Diaz [2], K. Soetaert [3], P. Auger [1], M. Herrmann [4] and C. Estournel [1]
[1] Laboratoire d'Aérologie - CNRS - Université de Toulouse 3, 14 avenue E. Belin, 31400 Toulouse, France - caroline.ulses@aero.obs-mip.fr
[2] Laboratoire d'Océanographie Physique et Biogéochimique, Marseille, France
[3] Centre for Estuarine and Marine Ecology, Netherlands Institute of Ecology, P.O. Box 140, 4400 AC Yerseke, The Netherlands
[4] CNRM – Météo-France, Toulouse, France

Abstract
The biogeochemical cycles of the major elements and the associated structure of the planktonic functional groups are investigated in the northwest Mediterranean Sea in relation with the seasonal and interannual variability of the hydrodynamic/atmospheric forcing.
Keywords: Western Mediterranean, Models

A 3D physical-biogeochemical coupled model has been implemented to represent cycles of biogenic elements (carbon, nitrogen, phosphorus and silica) and pelagic plankton groups in the NW Mediterranean Sea.

The hydrodynamic mesoscale SYMPHONIE model [1] has been used forced by high resolution atmospheric fluxes. The biogeochemical model is defined by three size groups of phytoplankton and of zooplankton, hetrotrophic bacteria, two size classes of particulate organic matter, dissolved organic matter and four inorganic nutrients. The representation of the phytoplankton processes is derived from the model ECO3M [2] that has been increased in complexity in the present work. The heterotroph model is an adapted version of the stoichiometric model developed by [3] and applied at the study area by [4].

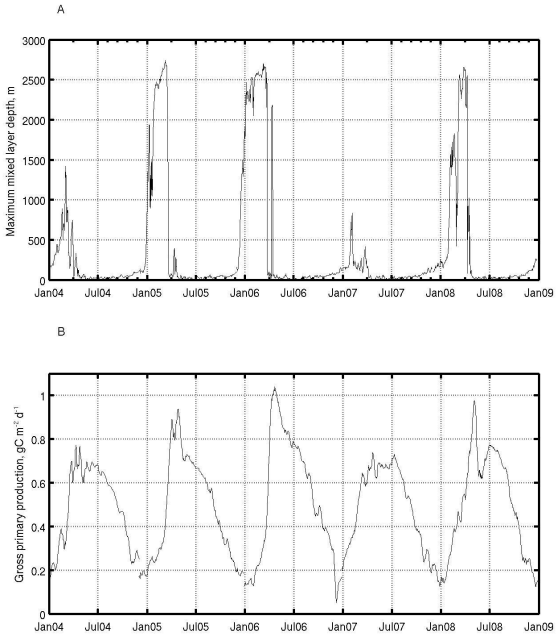


Fig. 1. Interannual variation of the simulated (A) maximum mixed layer depth (m) and (B) mean primary production (gC m^{-2} d^{-1}) over the north-western Mediterranean sea for the 2004-2008 period.

The calibration and validation of the coupled model were performed through comparisons with complementary observations: data at the DYFAMED deep station in the Ligurian Sea, data of SOMLIT coastal stations and satellite images. The model results reasonably reproduce the recorded spatial and temporal variations.

Then the model was used to estimate a budget of the biogenic elements in the area over the period 2004-2008 characterized by a varying intensity of the major physical (deep convection, shelf dense water cascading, general circulation) (Figure 1A) and biogeochemical processes (Figure 1B).

References
1 - Herrmann M.J., Somot S., Sevault F., Estournel C. and Deque M., 2008. Modeling the deep convection in the northwestern Mediterranean Sea using an eddy-permitting and an eddy-resolving model: Case study of winter 1986-1987. *J. Geophys. Res.*, 113: C04011.
2 - Baklouti M., Diaz F., Pinazo C., Faure V. and Queguiner B., 2006. Investigation of mechanistic formulations depicting phytoplankton dynamics for models of marine pelagic ecosystems and description of a new model. *Prog. Ocenogr.*, 71: 1-33.
3 - Anderson T.R. and Pondaven P., 2003. Non-redfield carbon and nitrogen cycling in the Sargasso Sea: pelagic imbalances and export flux. *Deep-Sea Res. I*, 50 : 573–591.
4 - Raick C., Delhez E.J.M, Soetaert K. and Grégoire M., 2005. Study of the seasonal cycle of the biogeochemical processes in the Ligurian Sea using a 1D interdisciplinary model, *J. Mar. Sys.*, 55: 177-203.

FOOTPRINTS OF MESOSCALE EDDY PASSAGES IN THE OTRANTO STRAIT (ADRIATIC SEA)

Laura Ursella [1], Vedrana Kovacevic [1], Miroslav Gacic [1]* and Isaac Mancero-Mosquera [1]
[1] OGS-Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy - mgacic@ogs.trieste.it

Abstract
Mesoscale eddies play an important role in transferring particles, nutrients and other passive material vertically or horizontally. Their typical dimensions are of the order of several internal radii of deformation. In the Adriatic Sea the baroclinic radius of deformation is of the order of 5 km. Here, the footprints of mesoscale eddies propagating through the Strait of Otranto are shown, and their formation mechanism and area are hypothesized.
Keywords: Adriatic Sea, Mesoscale Phenomena, Currents

Introduction
On average, an inflow takes place along the eastern coast of the Strait of Otranto (70 km wide and about 800 m deep channel connecting the Adriatic and Ionian - Fig.1), while the outflowing current occupies its western portion. Besides, an outflow of the Adriatic Dense Water (AdDW) occurs as a density-driven current in the bottom layer pressed against the continental margin of the western coast [1]. Previous observational studies in the Strait of Otranto [2] presented evidences on the unstable flow in the shear zone between the northward and southward currents and explained them in terms of the near-inertial waves and counterclockwise mesoscale eddies, appearing as a 10-day variability in the current record.

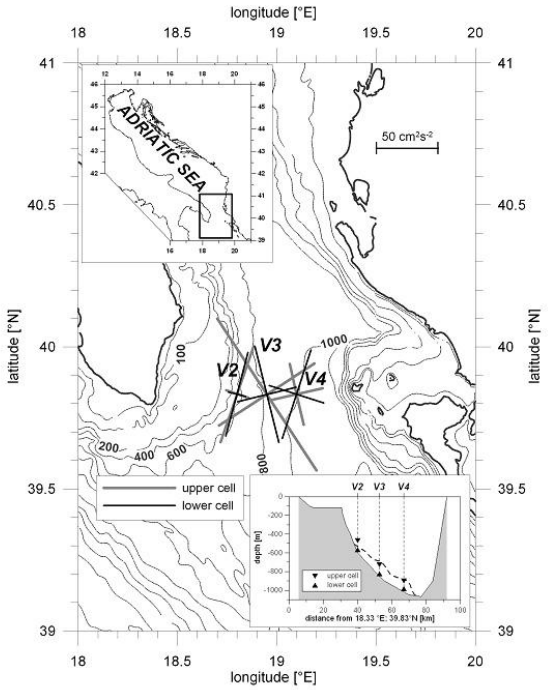


Fig. 1. Study area with the position of moorings and principal axes of sub-inertial current oscillations. Upper insert: Adriatic Sea with the study area denoted by the rectangle. Lower insert: the schematic of the vertical section with the three ADCP moorings positioned within the AdDW outflow (denoted by dashed line).

Data and Methods
Currentmeter data obtained from three moorings with bottom-mounted upward-looking Acoustic Doppler Current Profilers (ADCPs), that were maintained from September 1997 until June 1999 and from November 2006 until April 2007 at a transect in the core of the outflowing Adriatic Dense Water, are analyzed. Data were quality controlled and the missing data for periods less than 6 hours were linearly interpolated. Harmonic analysis was performed in order to de-tide the time series and, finally, a low-pass filter (33-hour cut-off period) was applied to remove inertial oscillations, thus obtaining sub-inertial non-tidal flow.

Results
The principal axis analysis of the sub-inertial flow shows that currents, especially those close to continental margins, are strongly polarized along isobaths (Fig.1). Low-pass records at all three moorings reveal energetic events of vertically uniform current vector rotation at about a weekly time-scale (Fig.2). Rotary spectra reveal their clockwise (counter-clockwise) sense of rotation at station V3 (V4), while wavelet analysis shows their timing. The two moorings close to the center of the strait show coherent current vector rotation suggesting a southwestward propagation of mesoscale eddies trapped by the bottom topography. Eddy dimensions are estimated to be between 20 and 30 km while the propagation speed is about 7 cm/sec. Eddy passage leaves a strong signal in the turbidity time-series as well, probably due to sediment resuspension by strong currents and their advection through a canyon. We hypothesize that the eddies' generation is based on the conservation of the potential vorticity for the water column passing over the sill about 100 km located upstream of the section, as suggested by [3] for the Denmark Strait. The stretching of the intermediate water layer induces cyclonic vorticity and the formation of eddies that propagate southwestward following isobaths.

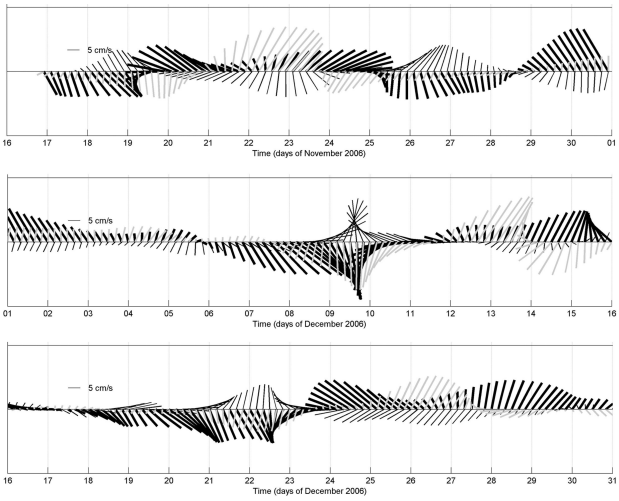


Fig. 2. Stick diagram of one cell per mooring for the period 16 November – 31 December 2006: V2 nominal cell depth 545 m (grey line), V3 nominal cell depth 720 m (black thick line) and V4 nominal cell depth 898 m (black thin line). The mean over the indicated period was removed from each time-series.

References
1 - Manca B.B., Kovacevic V., Gacic M. and Viezzoli D., 2002. Dense water formation in the Southern Adriatic Sea and spreading into the Ionian Sea in the period 1997–1999. *J. Mar. Sys.*, 33-34(C): 133-154.
2 - Kastanos N. and Ferentinos G., 1991. Mesoscale current variability in the Otranto Straits, Adriatic Sea. *J. Geophys. Res.*, 96, C3: 8741-8754.
3 - Spall M.A. and Price J.F., 1998. Mesoscale variability in Denmark Strait: The PV outflow hypothesis. *J. Phys. Oceanogr.*, 28: 1598-1623.

MERGING MEDATLAS DATA BASE AND NEW MONITORING PROGRAMS. WMED WARMING FROM 1900 TO 2008.

M. Vargas-Yáñez [1], F. Moya [1], M. García-Martínez [1]*, E. Tel [2], P. Zunino [1], F. Plaza [3], J. Salat [4], J. Pascual [4], J. López-Jurado [5] and M. Serra [5]

[1] Instituto Español de Oceanografia, Malaga, Spain - mcarmen.garcia@ma.ieo.es
[2] Instituto Español de Oceanografia, Madrid, Spain
[3] Institut de Ciencies del Mar (CSIC), Barcelona, Spain
[4] Instituto Español de Oceanografía, Mallorca, Spain
[5] Instituto Español de Oceanografía, Gijón, Spain

Abstract

Data bases such as MEDATLAS [1] have proved to be an extremely valuable tool for assessing long term changes. Nevertheless, recent works have shown that the irregular time and spatial distribution of data can decrease the robustness of the analyses [2, 3]. Monitoring programs with systematic samplings are required in order improve the estimations of long term changes, but this arises the question of whether or not data from new monitoring programs and "old" data bases can be merged in order to construct long time series. In this work we check the homogeneity of time series constructed from MEDATLAS data base and the monitoring program RADMED in the Spanish Mediterranean. Time series extending from 1900 to 2008 show the warming and salting of the Western Mediterranean (WMED).

Keywords: Western Mediterranean, Monitoring, Time Series, Temperature, Salinity

The Spanish Mediterranean was divided in four different areas (squares in fig. 1) and all the temperature and salinity profiles from 1900 to 2000 in MEDATLAS data base were compiled. Because of biases recently reported in batithermographs [4], only bottle and CTD data were used. Time series within each square were vertically interpolated at 23 pressure levels from 0 to 2500 dbar. These series were merged with averaged profiles obtained from oceanographic stations from RADMED (IEO) and l'Estartit oceanographic station (ICM/CSIC) within the corresponding square. In this way we construct temperature and salinity time series extending from 1900 to 2008.

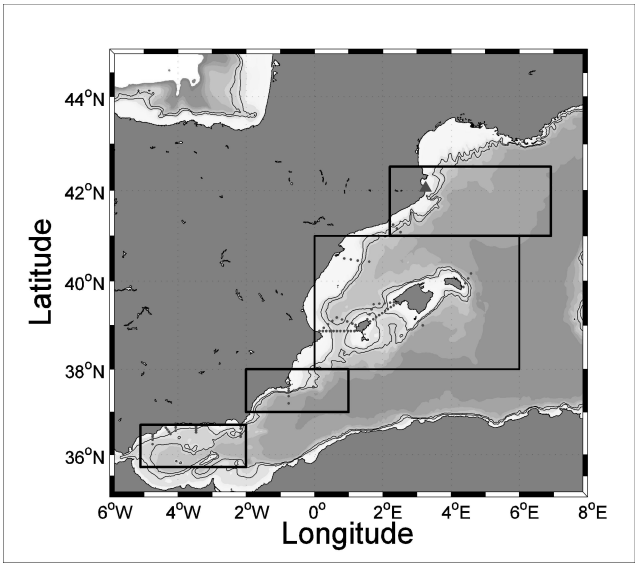


Fig. 1. Squares where MEDATLAS data were compiled and RADMED stations (dots). The triangle is l'Estartit oceanographic station.

First the homogeneity and normality of time series was checked by means of Alexanderson homogeneity tests and Kolmogorov-Smirnov tests. Both temperature and salinity time series were accepted as homogeneous after the corresponding tests. The length of these time series has shown that the WMED has increased its temperature at the three layers considered, that is, upper (0-200m), intermediate (200-600m) and deep (600m-bottom). The heat absorbed by the water column is equivalent to a heat gain of 0.23 Wm^{-2}. The salinity of the intermediate and deep layer also increased in a statistically significant way (fig. 2). These series show a strong decadal variability that makes it difficult to distinguish between those changes that are operating continuously in time, very likely as a result of climate change, and those that are the result of the inner variability of the climate system. The inclusion of data from the early twentieth century allow us to estimate long term changes, although decadal variability can not be resolved in this part of the time series. Our results highlight the non-linear character of the temperature and salinity time series and linear trends can only be considered as mean increments for the whole period of time. Furthermore, the homogeneity of the time series obtained and the continuity of the ongoing monitoring programs provides a tool for studying the effects of climate change in the Mediterranean. A correlation analysis with time series of heat absorbed by the upper 700m in the North Atlantic evidence that the WMED and the present time series can be considered as a proxy for larger scale climate change studies.

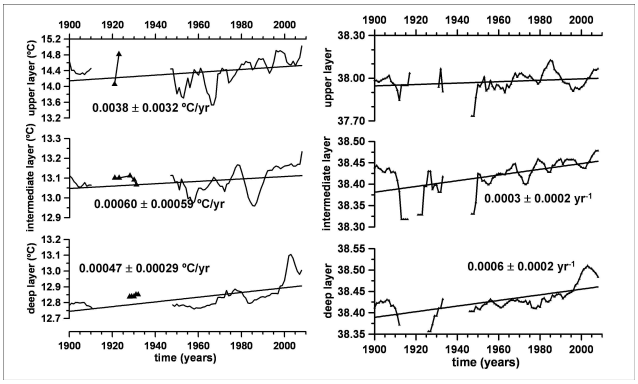


Fig. 2. Left column are mean temperatures for the upper, intermediate and deep layers averaged for the four areas selected. Right column is the same for salinity.

References

1 - MEDAR Group, 2002. MEDATLAS/2002 database: Mediterranean and Black Sea database of temperature salinity and bio-chemical parameters, *In:* Climatological Atlas [CD-ROM], Ifremer, Issy-les-Moulineaux, France.

2 - Vargas-Yáñez M., Moya F., Tel E., García-Martínez M.C., Guerber E. and Bourgeon M., 2009. Warming and salting of the Western Mediterranean during the second half of the XX century: Inconsistencies, unknowns and the effect of data processing. *Sci. Mar.*, 73(1): 7-28, doi: 10.3989/scimar.2009.73n1007.

3 - Vargas-Yáñez M., Zunino P., Benali A., Delpy M., Pastre F., Moya F., García-Martínez M.C. and Tel E., 2009. How much is the Western Mediterranean really warming and salting. *J. Geophys. Res.*, in press.

4 - Gouretski V. and Koltermann K.P., 2007. How much is the ocean really warming?. *Geophys. Res. Lett.*, 34, L01610, doi: 10.1029/2006GL027834.

TYRRHENIAN SEA CIRCULATION IN SPRING 2004: OBSERVATION AND MODEL RESULTS

A. Vetrano [1]*, E. Napolitano [2], R. Iacono [2], K. Schroeder [1] and G. Gasparini [1]
[1] CNR - Istituto di Scienze Marine, La Spezia, Italy - anna.vetrano@sp.ismar.cnr.it
[2] ENEA CR-Casaccia, Roma, Italy

Abstract

Hydrological and current measurements collected in the Tyrrhenian Sea during May-June 2004 are analyzed with an inverse box-model (IBM) to establish the mean spring circulation patterns of the basin. These patterns are compared with those provided by a high resolution, primitive equation model (POM) implemented over the area to simulate the mean basin circulation during the survey. The good agreement between the two circulation fields represents a solid evidence for the reliability of the estimated dynamical structures. Moreover, the POM reveals the short spatial variability of the basin not always resolved by IBM because of the low spatial resolution of the in-situ measurements. The comparative study indicates the Tyrrhenian basin as a highly dynamically active region of the Mediterranean Sea, characterized by a rich mesoscale dynamics.

Keywords: Circulation, Tyrrhenian Se, Mesoscale Phenomena, Models

The Tyrrhenian Sea (TS) is a deep basin of the Mediterranean Sea characterised by a complex bottom bathymetry: A narrow continental shelf, a large shelf slope and a deep central part with a large number of isolated volcanic seamounts. Up to the 90s, TS was considered the most isolated basin of the Western Mediterranean Sea, characterized by a wind-driven circulation. Recent findings suggest that TS is a key region for the water masses exchanges between the eastern and the western Mediterranean Sea, playing an important role as a reservoir of heat and salt for the Mediterranean basin [1, 2]. A detailed description of the circulation at the level of the main water masses is still lacking.

This work is aimed at achieving a novel picture of the typical TS spring circulation patterns, based on observations collected during two recent dedicated oceanographic cruises conducted between May and June 2004 (Fig. 1). The hydrographic dataset, integrated with long-term current measurements (at the Sicily strait and the Corsica channel), has been used to estimate the absolute geostrophic flow with a linear Inverse Box Model (IBM). The IBM method [3] provides a correction to the relative geostrophic velocity field, assuming conservation of water properties inside boxes, which are closed volumes of water bounded by the geographical margins (coastline and bottom) and by the hydrographic transects. Two isopycnal surfaces (28.9 kg/m3 and 29.1 kg/m3) are chosen as boundaries between layers, corresponding to the resident water masses: Atlantic Water (AW), Levantine Intermediate Water (LIW) and Tyrrhenian Deep Water (TDW).

The IBM assessment of the circulation has been compared with the simulated circulation from a high resolution numerical model (the Princeton Ocean Model, POM), forced with ECMWF wind stress fields averaged over the cruise period. Initial and boundary conditions are obtained by interpolating on the POM grid the temperature, salinity, velocity and surface elevation fields produced by the Mediterranean Forecasting System (MFS). Both the initial and the boundary data are averaged over the cruise period. The model is forced at the open boundaries by net mean barotropic transports simulated by MFS.

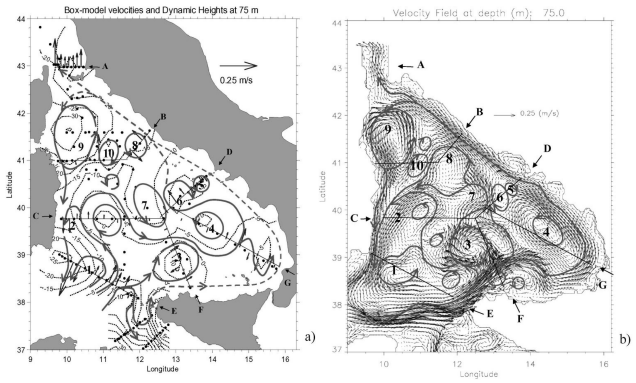


Fig. 1. Comparison between IBM (a) and POM (b) current fields at 75 m, representative for AW circulation.

Fig. 1a shows the IBM estimated geostrophic velocities (small arrows perpendicular to hydrological transects) at 75 m of depth, superimposed to the dynamic heights distribution (dotted curves) at the same depth, referenced to the surface. From both fields, a sketch of the main AW patterns (continuous curves) has been drawn and compared with a similar sketch resulting from the horizontal velocity field of the POM simulation (Fig. lb). The ten dynamical structures distributed all over the basin in both IBM and POM fields are numbered likewise, tolerating small differences in position and shape. The largest structure is the Bonifacio gyre 9, which is a permanent cyclonic circulation due to the year-round westerly jet of wind blowing through the Bonifacio strait. This gyre displays remarkably close features in the two estimates. Moving south, good agreement is found for the anticyclone 3, just above the Sicily tip, and for the cyclonic circulation 4, more to the east. The eddy 8 is well developed in POM as a wide current meander. Most of these structures are coherent with the corresponding intermediate and deep circulation patterns (not shown), indicating a strong barotropic component of the flow. For the sake of completeness, horizontal surface and intermediate mass fluxes for the main streams and gyres are shown in Fig. 2.

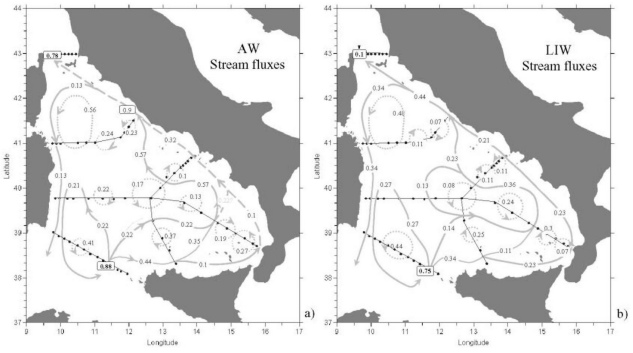


Fig. 2. IBM horizontal mass transports (Sv) through transects for AW (a) and LIW (b).

Concluding, the results indicate the presence of a rich mesoscale dynamics, until now poorly resolved, likely to be strongly influenced by the interaction of the surface forcing with the complex bathymetry of the basin. Moreover, the good agreement between the geostrophic reconstruction of the IBM and the velocity patterns of the POM indicates that the main deduced circulation patterns are representative of a typical TS spring condition.

References

1 - Astraldi M., Gasparini G.P., Vetrano A. and Vignudelli S., 2002. Hydrographic characteristics and interannual variability of water masses in the central Mediterranean: a sensitivity test for long-term changes in the Mediterranean Sea. *Deep-Sea Res.*, 49: 661- 680.

2 - Vetrano A. Gasparini G.P., Molcard R. and Astraldi M., 2004. Water flux estimate in the central Mediterranean Sea from an inverse box model. *J. Geophys. Res.*, 109, C01019, doi:10.1029/2003JC001903.

3 - Wunsch C., 1996. The ocean circulation inverse problem. Cambridge University Press.

LONG-TERM CHANGES IN DEEP ADRIATIC WATER MASSES OBTAINED BY SELF-ORGANISING MAP ANALYSIS

Ivica Vilibic [1]*, Hrvoje Mihanovic [2], Jadranka Sepic [1] and Slavica Matijevic [1]
[1] Institute of Oceanography and Fisheries, Setaliste I. Mestrovica 63, 21000 Split, Croatia - vilibic@izor.hr
[2] Hydrographic Institute of the Republic of Croatia, Zrinsko Frankopanska 161, 21000 Split, Croatia

Abstract
A novel approach in detecting and determining water mass changes is documented in the paper, based on a Self-Organising Maps (SOM) method. We used the method to extract and classify long-term variability (1957-2009) of temperature, salinity, dissolved oxygen and nutrients at a single station in the deep South Adriatic Pit. The extracted vertical profile patterns and their variability are associated with the known Adriatic water masses. We also tested the capacity of the method to recognize the masses by changing the dimensions of SOM nodes and by varying the number of input parameters.
Keywords: Adriatic Sea, Deep Waters, Time Series

Adriatic water masses are known to play an important role in ventilation of deep layers of the Eastern Mediterranean, and the South Adriatic Pit (SAP) is recognized as a place where most of the deep waters are formed [1] inside of a cyclonic gyre. The formation can be enhanced or modified by other masses [2]: (i) very cold North Adriatic Dense Water, which is turbulently sinking along the western SAP perimeter, and filling the deepest layers of the pit, and (ii) saline Levantine Intermediate Water (LIW) which is coming into the Adriatic through the Otranto Strait and preconditioning the generation of the Adriatic water masses. There are several studies describing a long-term variability and interplay between the Adriatic water masses [2, 3]. This paper will document the use of a state-of-the-art method for extraction of patterns from time series, the Self-Organising Maps (SOM) method, and its application to the long-term series of thermohaline and chemical parameters in the South Adriatic. We analysed the series of temperature (T), salinity (S), dissolved oxygen (DO), ortophosphate (HPO_4^{2-}) and total inorganic nitrogen (TIN) concentrations measured at the D1200 station (42º13'N, 17º42'E) located in the nortern SAP in the 1957-2009 period. These series have been quality checked for bad values, offsets and spikes, normalized by standard deviation and mean value of each parameter, and introduced to SOM.

SOM is an artificial neural network based on unsupervised learning [4]. It consists of a nonlinear cluster analysis mapping of high-dimensional input data onto a two-dimensional output space. The gaps in the input data are treated by the method, allowing SOM to effectively extract patterns from large data sets. Thus, the SOM method has been widely used in various fields of studies ranging from economics to sciences, including oceanography [5]. In this analysis we used 2x3 SOM arrays, which allows for the detailed extraction of the characteristic water profiles, but we also tested the sensitivity of the method by applying 2x2 and 3x3 SOM arrays to the data. Sensitivity to the input variables has been tested as well, by introducing different groups of parameters to SOM (all, without TIN, without HPO_4^{2-}, without DO, without nutrients, only T and S) and assessing the variations of characteristic patterns and Best Matching Unit (BMU) evolution in time. BMU is the number of the SOM solution that can be identified according to the minimum Euclidian distance between certain input data field and all SOM solutions.

Figure 1 plots the profiles of 2x3 SOM BMUs for all parameters. The profiles adequately resemble the Adriatic water masses. The resemblance is the most obvious for the salinity BMU profiles. For example, BMU1 can be associated to a strong LIW inflow to the Adriatic, as it is characterised by very high salinity, low DO and high nutrients in the intermediate layer. The generation of the Adriatic Deep Water (ADW) may be seen in BMU2 and BMU4, as these patterns are characterised by vertical homogeneity between 200 and 600 m. Temporal evolution of the BMU in time (not shown) depicts the variations of water masses in the area. For example, BMU1 is appearing around 1970, 1980, late 1980s and mid 2000s, when LIW intrusions have been detected [2]. However, some additional changes in BMU patterns and their temporal evolution are obtained when restricting the input variables to T, S and DO, and especially when using only T and S in the analyses.

The results highlight the advantageousness of the SOM for water mass assessment, as objective classification may be made for an area. Therefore, the method may be used for objective classification of the overall Adriatic masses, and may introduce new insights in our knowledge of existing water mass definitions, especially when including chemical parameters in such an analysis.

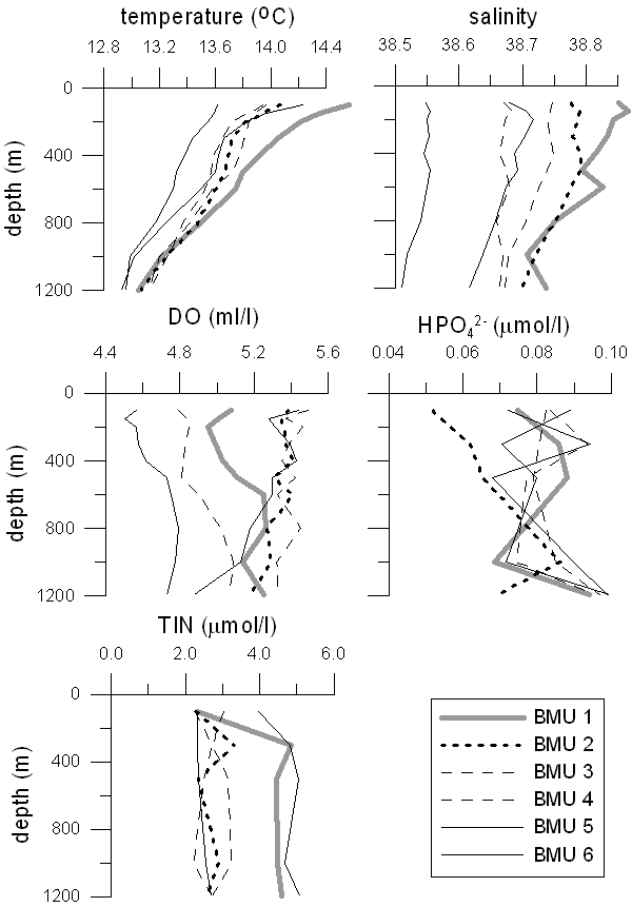


Fig. 1. Characteristic profiles (BMU1 to BMU6) of termohaline and chemical parameters as extracted by the 2x3 SOM from the data collected at D1200 station between 1957 and 2009.

References
1 - Rubino A. and Hainbucher D., 2007. A large abrupt change in the abyssal water masses of the eastern Mediterranean. *Geophys. Res. Lett.*, 34, L23607, 10.1029/2007GL031737.
2 - Vilibic I. and Orlic M., 2001. Least-squares tracer analysis of water masses in the South Adriatic (1967-1990). *Deep-Sea Res. I*, 48, 2297-2330.
3 - Vilibic I., 2003. An analysis of dense water production on the North Adriatic shelf. *Estuar. Coast. Shelf Sci.*, 56, 697-707.
4 - Kohonen T., 2001. Self-Organizing Maps, third ed. Springer-Verlag, New York, 501 pp.
5 - Liu Y., Weisberg R.H. and Mooers C.N.K., 2006. Performance evaluation of the self-organizing map for feature extraction. *J. Geophys. Res.*, 111, C05018, doi:10.1029/2005JC003117.

STRONG FORTNIGHTLY OSCILLATIONS OBSERVED IN THE ADRIATIC SEA

Ivica Vilibic [1]*, Jadranka Sepic [1], Vlado Dadic [1] and Hrvoje Mihanovic [2]
[1] Institute of Oceanography and Fisheries, Setaliste I. Mestrovica 63, 21000 Split, Croatia - vilibic@izor.hr
[2] Hydrographic Institute, Zrinsko Frankopanska 161, 21000 Split, Croatia

Abstract
This paper documents the occurrence of strong fortnightly oscillations in the Adriatic Sea, frequently observed in the current measurements. For that purpose we analyzed half-decadal sea level series and long-term currents collected within different parts and layers of the Adriatic Sea. The fact that strong 10-20 day currents are occasionally in-phase with the Mf sea level tide gives a hint on a possible mechanism responsible for the generation of these oscillations. Additionally, these currents are usually strongly amplified during a weakly stratified season, indicating a baroclinic mechanism responsible for the multiplication of the fortnightly currents.
Keywords: Adriatic Sea, Tides, Currents

There are a number of studies that document the 10-20 day oscillations in current fields, which are frequently observed in the Adriatic and Mediterranean Seas [1-4]. Although the atmospheric forces have been suggested as the generator of these oscillations, such a hypothesis is still not proved and no significant interconnection with the strongest currents has been found. Therefore, we attempted to connect the observations with another force not considered in any of the documented literature, and that includes the propagation of the fortnightly wave [5, 6] coming from the Atlantic Ocean through the Strait of Gibraltar, being modulated and amplified by the topography, stratification and atmospheric processes.

We focus our study in the Adriatic Sea, as continuous multi-decadal hourly sea level series are available there, together with several long-term (about a year) current measurements. We have used the data collected at the Rovinj (RO) and Split (SP) tide gauges from 1957 to 2005, and the ADCP deployed off Dubrovnik between 27 November 2007 and 23 January 2009 at the depth of 84 m. For the assessment of the atmospheric influence we used available hourly air pressure data from Bari (BA) and Trieste (TR) meteorological stations during the same interval, analyzing their difference (gradient) that generates the winds along the Adriatic.

First we performed classical spectral analysis and found that a significant sea level energy peak between diurnal and semi-annual periods is occurring only at 13.66 days, equalling the Mf tide period. By applying harmonic analysis we estimated a Mf amplitude of 0.89±0.42 cm at Split and of 0.97±0.44 cm at Rovinj, with no changes in phase between them, indicating that the barotropic Mf tidal wave is much larger than the Adriatic. Then we extracted 10-20 day currents from the ADCP station by applying a band-pass Butterworth digital filter. It may be seen that both the barotropic Mf currents and sea levels are often in-phase (Fig. 1), indicating a progressive nature of these oscillations. The predominantly barotropic currents are changing into baroclinic ones in early April, when stratification is beginning to develop in mid latitudes. The first oscillatory event, occurring in April, is in-phase with the air pressure gradient oscillations over the Adriatic, which is following the documented speculations on atmospheric origin of the generating force of 10-20 day oscillations. However, the second and the strongest 14-day oscillatory currents event in 2008 may be observed from mid May to early July, when the atmospheric pressure gradient at these periods was quite low. The oscillatory currents with maximum velocity amplitude of 15 cm/s were in-phase with the Mf tide for more then 4 cycles. The in-phase character between the current oscillations and the force, which may be observed through the water column, also indicates that the Mf tide could be the generating force.

Two other documented studies are favouring the Mf tide to be a generator of such oscillations. Martin et al. [4] tried to reproduce the fortnightly oscillations observed at Palagruža Sill by state-of-the-art ocean numerical model, which includes all of the atmospheric forcing but not fortnightly tides at the open boundary. They did not reproduce the oscillations, yielding us to the conclusion that the force is outside of the model like fortnightly tides. Other study, given by Kovacevic et al. [3], documents the 10-20 day variability in deep Otranto Strait currents. We found both observations to be in-phase with the Mf sea level tide in the Adriatic.

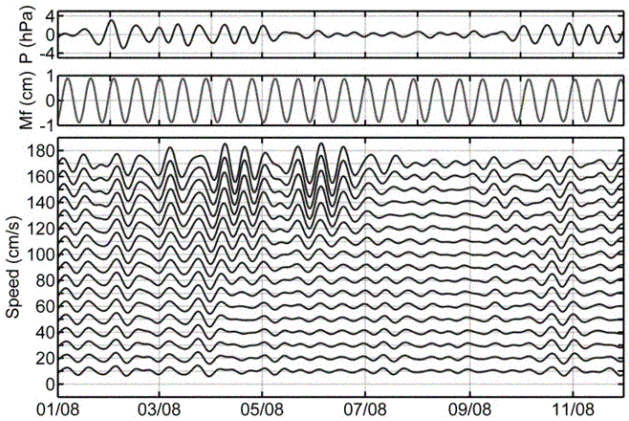


Fig. 1. The top panel shows band-pass filtered along-Adriatic air pressure differences as computed from Bari and Trieste measurements. The middle panel displays the Mf sea level tide. The bottom panel contains band-pass filtered alongshore currents measured off Dubrovnik in 2008 (the most top and most bottom current series are at 6 and 70 m, filled in by the equidistant 4-m layers).

We believe that similar fortnightly oscillations may be found in other parts of the Mediterranean Sea, still unexplained as nobody considered the Mf tidal wave as a possible generator. In addition, the significance and strength of the Mf tide over the open Mediterranean waters should be mapped through the process-oriented numerical studies, which will prove the capacity of the Atlantic Mf tide to propagate within the Mediterranean and to amplify at topographical barriers and during stratified conditions.

References
1 - Grancini G.F. and Michelato A., 1987. Current structure and variability in the Strait of Sicily and adjacent area. *Anna. Geophys.*, 5B: 75-88.
2 - Cerovecki I., Pasaric Z., Kuzmic M., Brana J. and Orlic M., 1991. Ten-day variability of the summer circulation in the northern Adriatic. *Geofizika*, 8: 67-81.
3 - Kovacevic V., Gacic M. and Poulain P.-M., 1999. Eulerian current measurements in the Strait of Otranto and in the Southern Adriatic. *J. Mar. Sys.*, 20: 255-278.
4 - Martin P.J., Book J.W., Burrage D.M., Rowley C.D. and Tudor M., 2009. Comparison of model-simulated and observed currents in the central Adriatic during DART. *J. Geophys. Res.*, 114, C01S05, doi:10.1029/ 2008JC004842.
5 - Wunsch C., Haidvogel D.B., Iskandarani M. and Hughes R., 1997. Dynamics of the long-period tides. *Prog. Oceanogr.*, 40: 81-108.
6 - Vargas J.M., García-Lafuente J., Candela J. and Sánchez A.J., 2006. Fortnightly and monthly variability of the exchange through the Strait of Gibraltar. *Prog. Oceanogr.*, 70: 466-485.

PHYTOPLANKTON RESPONSE TO PHYSICAL PROCESSES IN THE MEDITERRANEAN SEA: EOF ANALYSIS OF SATELLITE OBSERVATIONS

G. Volpe [1]*, B. Buongiorno Nardelli [1], P. Cipollini [2], R. Santoleri [1] and I. S. Robinson [2]
[1] ISAC-CNR Via Fosso del Cavaliere 100 - 00133 - Roma, Italy - g.volpe@isac.cnr.it
[2] NOCS Waterfront Campus European Way Southampton SO14 3ZH UK

Abstract
The relation between physical and biological processes affecting the Mediterranean Sea surface layer was investigated by means of different Empirical Orthogonal Function (EOF) decompositions over remotely sensed chlorophyll-a (CHL), sea surface temperature (SST) and Mediterranean Absolute Dynamic Topography (MADT) weekly time series (1998-2006). From the climatological point of view, there is an inverse relationship between CHL and SST, which is explained in terms of enhanced/reduced nutrient inputs to the surface layer as a result of the reduced/enhanced water column stratification. The correlation analysis over EOF results identified physical-biological interactions at both short and long term time scales, and from local to basin scales.
Keywords: Phytoplankton, Temperature, Sea Level

The relation between physical and biological processes affecting the Mediterranean Sea surface layer was investigated by means of different Empirical Orthogonal Function (EOF) decompositions over remotely sensed chlorophyll-a (CHL), sea surface temperature (SST) and Mediterranean Absolute Dynamic Topography (MADT) weekly time series (1998-2006). The EOF analysis generally requires complete time series of input maps, with no data voids. While respective data providers interpolated SST and MADT time series, CHL maps present several data voids due to the presence of persistent cloud cover. In this context, in order to fill in missing data, the Data INterpolating Empirical Orthogonal Functions (DINEOF) technique was applied to CHL images. A validation exercise, comparing 1304 *in situ* observations with space-time co-located satellite data, showed that, at weekly time scales, the DINEOF procedure improves data quality by filtering out the noise.

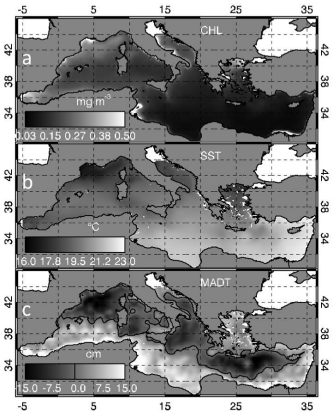


Fig. 1. Field climatologies (1998-2006) for CHL (a), SST (b) and MADT (c). Zero level contour line is superimposed onto the MADT map.

From the climatological point of view, a tight correlation exists between CHL and both SST and MADT (Fig.1). The basin and sub-basin scales inverse relationship between CHL and SST (r=0.64) is explained in terms of Behrenfeld hypothesis [1]: i.e., surface heating enhances water column stratification, which in turn prevents nutrient entrainment into the euphotic mixed layer, and vice versa. At more local scale, highly productive open-ocean areas are found to correspond with well-known and defined dynamical structures (as highlighted by the MADT field): in the WMED, these areas are represented by the cyclonic gyre in the Gulf of Lion, and all along the Algerian Current from the western Alboran Gyre down to the border between Libya and Tunisia across the southern sector of the Sicily Channel. In the EMED, this coupling appears in relation to the Ierapetra Gyre, though less clearly.

This analysis, on a side, provides enlightening insights on the physical-biological coupling, but on the other it is unable to investigate such a coupling on other than climatological time scales. The correlation analysis applied to EOF results, by exploring all time scales, helps giving deeper comprehension about these relationships. Results from the single EOFs, along with a cross-correlation analysis, identified physical-biological interactions at both short and long term temporal scales, and from local to basin spatial scales. In particular, the high correlation (r=0.9) between CHL and SST first modes describes the immediate response of phytoplankton concentration to the annual cycle of the water column stratification, at both basin and sub-basin scales. A completely different mechanism links the MED open ocean spring bloom to the DWF processes, in the north western MED. This is described by the 5.5 months phytoplankton delayed response to local surface cooling (as described by CHL and SST second modes). In fact, on one hand, the total amount of nutrients available in the offshore surface waters depends on the deep convection events occurring in late winter [2]. On the other hand, the DWF phenomena are characterized by a fundamental pre-conditioning phase, during which the surface stratification is significantly reduced.

Despite the good correlation between phytoplankton biomass variability and the temperature field at seasonal time scale, this analysis was unable to identify the co-variability between the two parameters at interannual timescale. We interpret this as due to the strong annual component, which definitely dominates the overall signal within both the first two EOF modes. In order to highlight then the presence of longer time scale signals and to investigate the covariance between the phytoplankton biomass and surface conditions at interannual timescales, the annual cycle and higher frequency signals have been removed from EOF data input. This data manipulation consisted in removing the weekly climatology from each weekly field of the time series, and then of applying a low-pass filter (one year moving average). This data filtering showed the link between phytoplankton biomass variability and two distinct interannual signals: a) the modified surface circulation pattern consisting in a northward shift of the Algerian current, along with its intensity increase, and the reduced cyclonic circulation in the whole eastern basin; b) to the surface heat content anomalies during 1998/1999 (particular cold winter) and 2003 (summer heat wave). This data filtering enabled to investigate the processes that influence the phytoplankton space and time distribution over longer time scales. In particular, the phytoplankton biomass variability was linked to two distinct interannual signals. The first is the modified surface circulation pattern consisting in a northward shift of the Algerian current, along with its intensity increase, and the reduced cyclonic circulation in the whole eastern basin (r=-0.87). One possible explanation is that the reduced advection of the relatively richer waters of Atlantic origin (in terms of nutrients and biomass) in the Tyrrhenian and Ionian Seas and its increased dispersal into the western WMED result in a progressive decrease of F-LCHL concentration in the central MED, creating the positive patch in the western WMED. The second is the surface heat content anomalies in 1998/1999 (particular cold winter) and 2003 (summer heat wave) (r=0.52), driving the phytoplankton dynamics in the central WMED, with few months delay. The observed impact of the water column stratification dynamics onto the phytoplankton biomass variability recalls the described simple model [3].

References
1 - Behrenfeld, M., O'Malley R.T., Siegel D., McClain C., Sarmiento J.L., Feldman G.C., Milligan A.J., Falkowski P., Letelier R. and Boss E., 2006. Climate-driven trends in contemporary ocean productivity, *Nature*, 444: 752-755, doi:710.1038/nature05317.
2 - Levy, M., Memery L. and Madec G., 1999. The onset of the Spring Bloom in the MEDOC area: mesoscale spatial variability, *Deep-Sea Res. I*, 46 (7): 1137-1160.
3 - Doney S.C., 2006. Plankton in a warmer world, *Nature*, 444: 695-696.

DIRECT ESTIMATE OF WATER, HEAT AND SALT TRANSPORT THROUGH THE STRAIT OF OTRANTO

Sadegh Yari [1]*, Miroslav Gacic [1], Vedrana Kovacevic [1] and Vanessa Cardin [1]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, 34010, Trieste, Italy - syari@ogs.trieste.it

Abstract
Water, heat and salt transport across the Strait of Otranto are estimated. Historical data sets (from December 94 through November 95) are used in this study [1, 2]. A new methodology (Variational Inverse Method [3]) is used to reconstruct the current, temperature and salinity fields over a regular grid, from the sparse measurements across Strait of Otranto. The direct method [4], which is simply spatial integration of production of current, potential temperature, specific heat capacity and water density over the transect area, is applied to gridded data to calculate the transport rates. The air-sea heat fluxes are calculated for the period of study to compare with heat advection through the Strait. The fresh water budget is estimated as well.
Keywords: Adriatic Sea, Strait Of Otranto, Water Transport, Heat Budget

The water, heat and salt transports through the Strait of Otranto are estimated applying direct method to historical current and hydrographical data (from December 94 through November 95). A variational inverse method based on a variational principle and a finite element solver is used to reconstruct the current, temperature and salinity fields across the Strait section from sparse measurements. Characteristics of the current field obtained by this new application are comparable to the historical studies [2]. The main features, such as the existence of the horizontal anticlockwise shear in the strait with inflow (northward currents) on the east and outflow (southward currents) on the west, and a two-layer system in the central deep portion (with inflow in the surface and outflow in the bottom layer) are reproduced. The mean annual inflow and outflow water transport rates are estimated as 0.901±0.039 Sv and -0.939±0.315 Sv, respectively, and the net transport is equal to -0.032±0.208 Sv. Thus, on a yearly time interval, the inflow and the outflow are practically compensated. The seasonal variation of water transport across the Strait of Otranto shows that the maximum exchanges take place during winter and spring, while the minimum exchanges are in summer. The errors of the inflow transport rates are almost always less than 10%, while the errors of outflow transport rates have large values 30%-50%. This is due to low spatial resolution of the current measurements in the lower layer of the central part of the cross section, which is located mostly in the outflow region. Consequently, the higher error on outflow influences the net transport rates and finally these estimations are associated with larger errors.

The heat and salt transports due to advection process are calculated for the first time. These estimations are carried out for five monthly periods, namely December 1994, February, May, August and November 1995. Considering these five periods representative of the seasonal cycle during the year (Autumn 1994 and four seasons of 1995), their average values show that there is a net heat advection into the Adriatic Sea on a yearly basis. The estimated value of advected heat and the corresponding error are 2.408±0.490 TW, which is equivalent to a heat gain of 17.37±3.53 W m^{-2} for the whole basin. The heat exchange through the air-sea interface is estimated by applying the bulk formulas to the meteorological data, namely the ERA-40 reanalysis data set extracted from European Centre for Medium-Range Weather Forecasts (ECMWF). The average surface heat flux for the study period is estimated as a heat loss of -36±152 (std) W m^{-2} through the air-sea interface over the Adriatic Sea. The final estimates of the advected heat through the Strait of Otranto are compared and discussed with the relationship to air-sea heat exchange over the Adriatic Sea. The two values are expected to balance each other in order to close the heat budget of the basin. The possible reasons for a difference to occur are discussed. On an annual time scale the advected heat should be compensated with the air-sea heat loss. However, on a seasonal time scale a significant disagreement might be expected. This is due to seasonal variation of the heat content of the Adriatic Sea, seasonal cooling or warming. Moreover, it can be related to the fact that the heat advection and surface heat exchange are basically two different mechanisms in time and space. Therefore, the spatial and temporal scales of these processes are different. Consequently, they can not balance each other on a short time scale as monthly or even a seasonal one. The potential temperature distribution indicates that the upper layer (first 200 m from the surface, including thermocline layer) is associated with higher temperature and elevated variability, while the lower layers are associated with lower temperature and smaller variability. This fact may set up the different role that each of the two layers plays in transporting heat. To examine this, the heat transport rates are then calculated for the two layers separately: the upper layer from sea surface down to 200 m depth and the lower layer from 200 m depth to bottom. The results show that the upper layer has larger contribution to the heat transport into the Adriatic Sea (heat gain), and as the net heat transport, the inflow of heat prevails in this layer. The lower layer contributes significantly to the heat transport away from the Adriatic Sea (heat loss). In fact, the net heat transport rates are negative, which means that the outflow of heat dominates in this layer.

The effect of temporal variation of the temperature field, which remains unsolved by using hydrographic surveys, is examined by simultaneous time series of current and temperature measurements. The contribution of eddy heat fluxes to total heat advection is estimated. The contribution is less than 6% [5]. Therefore, by calculating the heat transport from averaged current and temperature distributions, we asses the major part of the total heat transport, and consider it as representative of the total heat due to advection. The direct estimation of heat transport can be used as a constraint for validating the air-sea heat fluxes [6]. Therefore, by considering the advected heat as a reference, one can tune the bulk formulas to modify the estimation for the air-sea heat fluxes.

On a yearly basis, the salt transport is estimated as an input of salt equal to 0.05×10^6 Kg s^{-1}. The average annual fresh water budget is estimated as -0.002 Sv, equivalent to 0.45 m yr^{-1} for the entire Adriatic Sea. The import of salt that is less than the gain of fresh water is in agreement with the fact that the Adriatic Sea is a dilution basin. The brief results of water, heat, salt and freshwater transports are presented in Table 1 [5].

Table 1. Water, heat, salt and freshwater transports across the Strait of Otranto [5]. Units are in Sv (10^6 m^3 s^{-1}), TW (10^{12} Watts) and MKg/s (10^6 Kgs^{-1}).

Period	Water (Sv)	Heat (TW)	Salt (MKg/s)	Freshwater (Sv)
Dec. 94	0.045 ± 0.182	2.068 ± 0.148	0.007 ± 0.086	-0.001
Feb. 95	0.163 ± 0.206	2.633 ± 0.259	0.033 ± 0.091	-0.001
May 95	0.055 ± 0.232	1.718 ± 0.293	0.065 ± 0.058	-0.002
Aug. 95	-0.118 ± 0.177	3.287 ± 0.151	0.079 ± 0.048	-0.002
Nov. 95	0.104 ± 0.274	2.338 ± 0.207	0.049 ± 0.053	-0.001
Mean	-0.032 ± 0.208	2.408 ± 0.490	0.046 ± 0.031	-0.002

References
1 - Kovacevic V., Gacic. M. and Poulain P.-M., 1997. Eulerian current measurements in the Strait of Otranto and in the Southern Adriatic. *J. Marine Syst*., 20: 255-278.
2 - Vetrano A., Gacic. M. and Kovacevic V., 1996. Water fluxes through the Strait of Otranto. In: Proceedings of the workshop "Physical and biogeochemical processes in the Adriatic Sea", Portonovo (Ancona), Italy, 127-137.
3 - Brasseur P.P., 1991. A variational inverse method for the reconstruction of general circulation fields in the northern Bering Sea. *J. Geophys. Res*., 96: 4891-4907.
4 - Hall M.M. and Bryden H.L. 1982. Direct estimates and mechanisms of ocean heat transport. *Deep-Sea Res*., 29 (3A): 339-359.
5 - Yari S. 2009. Heat and salt transport across the Strait of Otranto. PhD dissertation. Università degli studi di Trieste. 77 pp.
6 - Bryden H.L. and Imawaki S., 2001. Ocean Heat Transport. In: Ocean Circulation and Climate, Siedler G., Church J., Gould J. eds., Academic Press, 455-474.

DARDANOS: A WERA SYSTEM FOR MONITORING THE DARDANELLES OUTFLOW IN THE AEGEAN

V. Zervakis [1]*, G. Korres [2], Z. Kokkini [1], E. Tragou [1] and T. Karambas [1]
[1] Department of Marine Sciences, University of the Aegean, Mytilene, Greece - zervakis@marine.aegean.gr
[2] Institute of Oceanography, Hellenic Centre for Marine Research, Anavissos, Greece

Abstract
The University of the Aegean and the Hellenic Centre for Marine Research have jointly installed a WERA HF radar system at the eastern coast of the island of Lemnos, Greece, in an effort to continuously monitor the surface Dardanelles current, a permanent feature carrying Black Sea Waters into the North Aegean Sea. Through this effort, the two Greek institutions aim ato estimating the volume flux of Black Sea Waters into the Aegean, as well as fluxes of biochemical properties responsible for the meridional oligotrophy gradient in this Mediterranean basin.
Keywords: Aegean Sea, Coastal Systems, Dardanelles, Black Sea

The Mediterranean and Black Seas are two neighboring seas of highly contrasting thermohaline and biochemical character, connected through the Turkish Straits System (TSS, i.e. the Dardanelles Strait, the Marmara Sea and the Bosphorus Strait). The water exchange through the Straits plays a critical role in the thermohaline and biogeochemical functioning of both seas. The deep layer of the Black Sea is continuously fed by Mediterranean waters through the subsurface Bosphorus current, maintaining the high salinity stratification of the basin [1] and thus, their permanently anoxic conditions [2]. The Black Sea waters (BSW) entering the Mediterranean as the surface Dardanelles current, form a light brackish layer over the North Aegean, playing a crucial role in controlling deep water formation processes in the region [3], and maintaining a meridional gradient in the oligotrophy of the Aegean Sea [4]. It is still unclear from climatic predictions whether the freshwater deficit of the Mediterranean, or the warming of the sea will prevail, thus contributing to lower or higher stratification of the sea. Thus, the insulating role of the BSW surface layer of the North Aegean may become even more crucial in controlling the thermohaline functioning of the basin. As the freshwater budget over the large Black Sea catchment area largely determines the characteristics of the exchange, the latter may become a significant climatic index for the region. For the above reasons, the University of the Aegean and the Hellenic Centre for Marine Research have recently installed a WERA High Frequency system for monitoring surface currents on the east coast of Lemnos island. The HF system, named "Dardanos", is able to monitor surface currents at semi-hourly intervals and 1.5 km resolution as far as the Dardanelles exit, thus providing a formidable tool for high-frequency monitoring of the surface circulation of the region (figure 1).

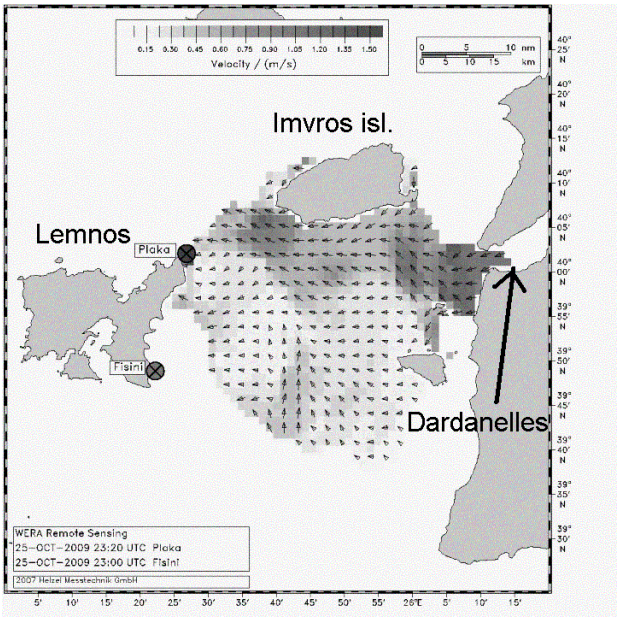


Fig. 1. Surface current map from October 25th, 2009. The darker shades at the northern part of the domain (corresponding to higher velocities) define the extent of the Dardanelles current

Our initial planning required that the system's range extends to the mouth of the Strait, in order to be able to separate the Dardanelles Current from a very energetic anticyclone that often contributes to the current through the Lemnos - Imvros channel. The HF system has been in operation since October 2009, and preliminary analysis of the data reveals that the system fulfills the above requirement about 30% of the time. Furthermore, the range of the system appears to vary depending on weather conditions. We examine the potential bias such behaviour could pose on the estimated Dardanelles volume fluxes.

A possible challenge is the estimation and removal of Stokes drift from the observed currents in order to assess the Dardanelles outflow. It should be noted that a linear antenna array (beam forming method) would permit a direct measurement of the wave field, however such a methodology was not applicable in this case due to topographic restrictions. Preliminary analysis has also revealed the sporadic presence of areas of erratic measurements, possibly due to electromagnetic noise in the region. Such errors should be readily removed through statistical methods.

While HF radars are being used worldwide mainly for operational purposes and for process studies (especially for coastal dynamics studies), it is -to our knowledge- the first time that such a system will be exploited in climatological monitoring of basin exchange and thermohaline functioning. The Department of Marine Sciences of the University of the Aegean aims at exploring different methodologies of estimating mixed-layer-depth and assume slab-layer behaviour in an effort to estimate the volume flux of Black Sea Waters into the Mediterranean. This time series will be compared with estimates from previous studies. The Hellenic Centre for Marine Research plans to exploit the information in improving its circulation predictions for their operational oceanography project and other climatological applications. The produced information will also be available for studies of the ecological functioning of the North Aegean, of pollutant dispersion (taking the Dardanelles exit as a potential point source of pollution in case of a marine accident), and in any related operational oceanography applications.

The installation of the HF system in Lemnos was supported by the project "Prevention and management of sea-originated risks to the Coastal Zone (CORI), funded by INTERREG-IIIB Archimed. Testing and quality control was supported by the MarinERA MedEX project.

References
1 - Besiktepe S., Özsoy E. and Ünluata Ü, 1993. Filling of the Marmara Sea by the Dardanelles lower layer inflow. *Deep-Sea Res. I*, 40 (9): 1815-1838.
2 - Özsoy E. and Ünlüata Ü.,1997. Oceanography of the Black Sea: a review of some recent results. *Earth-Sci. Rev.*, 42: 231-272.
3 - Zervakis V., Georgopoulos D. and Drakopoulos P.G., 2000. The role of the North Aegean in triggering the recent Eastern Mediterranean climatic changes. *J. Geophys. Res*., 105: 26103-26116.
4 - Siokou-Frangou I., Bianchi M., Christaki U., Christou E., Giannakourou A., Gotsis O., Ignatiades L., Pagou K., Pitta P., Psarra S., Souvermezoglou E., Van Wambeke F. and Zervakis, V., 2002. Organic Carbon partitioning and Carbon flow along a gradient of oligotrophy in the Aegean Sea (Mediterranean Sea). *J. Marine Syst.*, 33-34: 335-353.

THE CYPRUS WARM EDDY AND THE ATLANTIC WATER DURING THE CYBO CRUISES (1995-2009)

George Zodiatis [1]*, Dan Hayes [1], Isaac Gertman [2] and Yianna Samuel-rhoads [1]
[1] Oceanography Centre, University of Cyprus, Nicosia, Cyprus - gzodiac@ucy.ac.cy
[2] Israel Oceanographic and Limnological Research, Haifa, Israel

Abstract

In '80s, during the few seasonal POEM (Physical Oceanography of the Eastern Mediterranean) cruises in the SE Levantine Basin was first depicted a mutli-pole gyre, the Shikmona, formed by three eddies with the Cyprus one being most pronounced and an offshore cross basin current, the Mid Mediterranean Jet. A considerable much larger amount of seasonal in-situ data were collected from various observing platforms in the SE Levantine Basin from 1995-2009, mostly in the framework of the CYBO cruises and secondary by some other collaborative cruises and projects. These new in-situ data sets show a strong spatial and temporal variability of the Cyprus warm core eddy, of the Atlantic Water and of the associated MMJ displacement in the area.

Keywords: Levantine Basin, Circulation Models, Cyprus Arc, Currents

Preface

The general circulation in the Eastern Mediterranean as inferred from several cruises in 1960s and 70s [1], shows an anticlockwise flow with sub-basin features in the Levantine Basin, with the Rhodos gyre being the most well pronounced. In '80s, during the POEM international field experiments [2,3], a more detailed structure of the mesoscale circulation was defined to consist of several alternative cyclonic and anticyclonic gyres and eddies. Further, it was first shown that as a result of the interaction between these cyclonic (Rhodos) and anticyclonic (Mersa Matruh and Shikmona) gyres, an offshore cross basin jet is generated, named the Mid Mediterranean Jet (MMJ). In the SE Levantine the POEM group defined the Shikmona gyre as a multi-pole gyre, consisting of 3 eddies, of which the Cyprus one is the most well pronounced. Despite the fact that the Levantine Basin is characterised with the highest salinity at the surface and intermediate layers of the Mediterranean, less saline waters of Atlantic origin spread at the sub-surface layers, almost throughout the basin, as a results of the water volume compensation for the high rates of the sea water evaporation in the Levantine and of the outflow of the intermediate water into the North Atlantic [1].

Discussion and Results

The analysis of new in-situ datasets gathered in the SE Levantine during the period 1995-2009 from CYBO and CYCLOPS cruises, HaiSec cruises, NRT data of the CYCOFOS observing system, as well as extended use of satellite remote sensing data collected during the same periods, helped define in details not only the daily and seasonal, but also the inter-annual variability of the dominated mesoscale flow features and of the water masses displacement in the region.

These long term seasonally collected in-situ datasets reveal that the dominant and permanent flow feature in the SE Levantine is the Cyprus warm core eddy, that undergoes significant seasonal and inter-annual fluctuations in terms of its shape, size, intensity and location. Moreover, the establishment of a secondary warm eddy in the SE part of the study area was found during periods when the Cyprus eddy became weaker, as was shifted westward for about 80 nm away from Eratosthenes SM. Also during the long term CYBO campaigns it was found the re-establishment of the non permanent Shikmona gyre, when the co-existence of 2-3 warm eddies was observed. Particularly, during certain short periods related to the generation and destruction mechanism of the warm core eddies circulated within the Shikmona gyre, when it is present. The latter is recently evident from drifters trajectories, gathered by the NEMED project, which show that the instability of the strong northward current flowing along the Israel-Lebanese coast generated an anticyclonic eddy. The latter, detached away from this northward current towards the area of the secondary eddy, as observed by CYBO cruises.

These new data confirm the previous works [2, 3] that the MMJ enters the study area from the southwest, after crossing offshore the basin from the southwest. Furthermore during the CYBO cruises it was found that this jet meanders between Cyprus and the northern periphery of the Cyprus warm core eddy [4, 5]. The Cyprus warm core eddy, the Shikmona gyre (when appears), the smaller-scale non permanent cyclonic and anticyclonic eddies in the region, increase the complexity of the MMJ flow path and thereby of the AW transport in the SE Levantine.

The AW in the SE Levantine is very well pronounced during summer periods, mostly at the sub-surface depths, below the thermocline (~40 m) and down to the depth of ~80m, with salinity as low as 38.65-38.9. Periodically the AW was also defined at the surface, in the western part of the SE Levantine. During winter mixing processes the AW mostly is absent from the region, however, in winter periods with mild weather conditions all over the Mediterranean, the AW can be traced in the study area at the surface too. Throughout the study period the AW is well pronounced south and southwest of Cyprus. The MMJ is documented to transfer the AW eastward within the Levantine Basin. It was found that the MMJ transfers the AW along the periphery of the Cyprus warm core eddy, at the subsurface layers. AW has also been observed close to the Egyptian coast, as a result of a westward re-circulation, either of the MMJ or of a current flowing eastward along and closer to the Egyptian coast. During most of the examined periods the MMJ was found to be a main flow pathway for transferring the AW within the SE Levantine Basin.

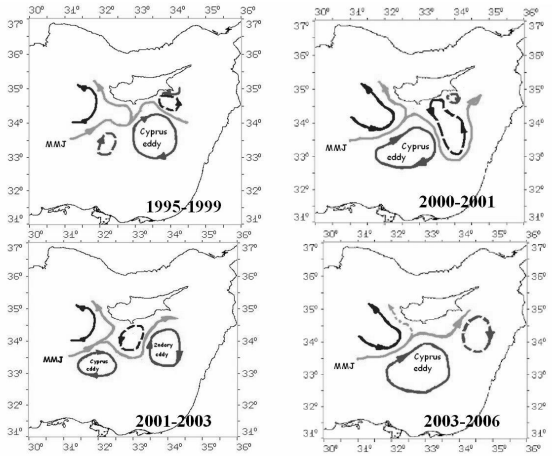


Fig. 1. Schematic of the general circulation in the SE Levantine showing the Cyprus eddy, the secondary eddy and the MMJ, as depicted from the CYBO cruises, 1995-2009.

References

1 - Ovchinnikov I.M, Plakhin A., Moskalenko L.V., Neglyad K.V., Osadchiy A.S., Fedoseyev A.F., Krivoscheya V.G. and Voytova K.V., 1976. Hydrology of the Mediterranean Sea. Gidrometeoizdat, Leningrad, 375 pp.

2 - Özsoy E, Hecht A., Ünlüata U., Brenner S., Oguz T., Bishop J., Latif M.A. and Rosentraub Z., 1991. A review of the Levantine Basin circulation and its variability during 1985-1988. *Dyn. Atmos. Oceans*, 15: 421-456.

3 - POEM group, 1992. General circulation of the eastern Mediterranean sea. *Earth Sci. Rev*., 32: 285-309.

4 - Zodiatis G., Drakopoulos P., Gertman I., Brenner S. and Hayes D., 2005. The Atlantic Water Mesoscale Hydrodynamics in the Levantine Basin. *In*: 37th CIESM Workshop Monograph-Strategies for understanding mesoscale processes.

5 - Zodiatis G., Drakopoulos P., Brenner S. and Groom S., 2005. Variability of the Cyprus warm core Eddy during the CYCLOPS project. *Deep-Sea Res. II*, 52: 2897–2910.

VARIABILITY ON ISOPYCNAL AND ISOBARIC SURFACES ASSOCIATED TO THE WESTERN MEDITERRANEAN TRANSITION

Patricia Zunino [1]*, Katrin Schroeder [2], Gian Pietro Gasparini [2] and Manuel Vargas-Yañez [1]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga, Fuengirola, Spain - pzunino@ma.ieo.es
[2] Consiglio Nazionale delle Ricerche. Istituto di Scienze Marine, La Spezia, Italy

Abstract
In the deep layers of the Western Mediterranean, an almost constant trend towards higher temperature and salinity has been observed since the 50´s, with an acceleration on these trends in the 90´s decade, as a result of the propagation of the EMT signature, from east to west. Indeed, an exceptional deep water formation event has been documented in winter 2004/2005 in this basin. After this intense event, the large volume of new deep water formed has caused an uplifting of the old deep water, replenishing the deep basin with the new warmer and saltier water. In order to detect the effects of water mass changes and vertical displacement, we investigated the variability of seawater properties on isopycnal and isobaric surfaces from 1995 to 2008, with special attention to the last years, when the WMT have been happening.
Keywords: Western Mediterranean, Deep Waters, Density

The recent acceleration of deep temperature and salinity changes in the Western Mediterranean (WMED) [1] has been followed by a major change in the basin after 2005 deep water formation processes. These events have produced the basin-wide spreading of a deep thermohaline anomaly, which is called Western Mediterranean Transition (WMT, [2]). Temperature and salinity changes on isobaric surfaces have two effects added: changes along isopycnal surfaces (related to water mass changes) and those induced by the vertical displacement of isopycnals (related to wind stress curl and formation rate of deep water) [3]. These authors proposed the following equation to evaluate how the two effects lead to changes on each pressure level:

$$\left.\frac{d\theta}{dt}\right|_p = \left.\frac{d\theta}{dt}\right|_\sigma - \left.\frac{dp}{dt}\right|_\sigma \frac{\partial\theta}{\partial p}$$

This methodology has recently been applied for the first time in the WMED [4]. The aim of the present work is to indentify how intense deep water events could move upward old deep water and what would be the effect of the vertical displacement of isopycnals (referred to as heaving [3]) when temperature and salinity changes are studied on isobaric surfaces. We focus on the WMT because of the larger volume of deep water formed than previous years. Therefore, the heaving should have an important effect on temperature and salinity changes estimated on isobaric surfaces.

We have analyzed temperature and salinity data from the DYFAMED station from 1995 to 2008, as well as data from different surveys carried out from 2004 to 2008 on board of the R/V Urania, owned by CNR-ISMAR.

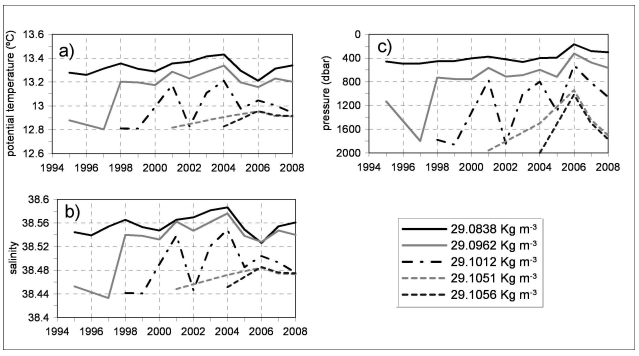


Fig. 1. A) Potential temperature, b) salinity and c) pressure evolution along some selected density surfaces from 1995 to 2008. Data from the DYFAMED station.

Preliminary results show salinity and temperature increases along both isopycnals and isobaric surfaces since 1995 up to 2004 in the intermediate and deep layers (fig 1 a and b show temperature and salinity evolution along isopycnal surfaces). But, after the WMT event, temperature and salinity increase in the bottom layers while they decrease in the intermediate layer. Concerning the WMT, the volume of deep water generated during this event is larger than in previous years [5], causing the upward displacement of old deep water (Figure 1c shows the shallowest levels achieved by all the represented isopcynals in 2006). The effect of this upward movement was a cooling and freshening on isobaric surfaces (dashed black line in fig 2 A and B). In this case isopycnal and heaving contribution have the same sign, adding both effects, resulting in a cooling and freshening effect on isobaric surfaces which are larger than those that really affected the water masses by themselves.

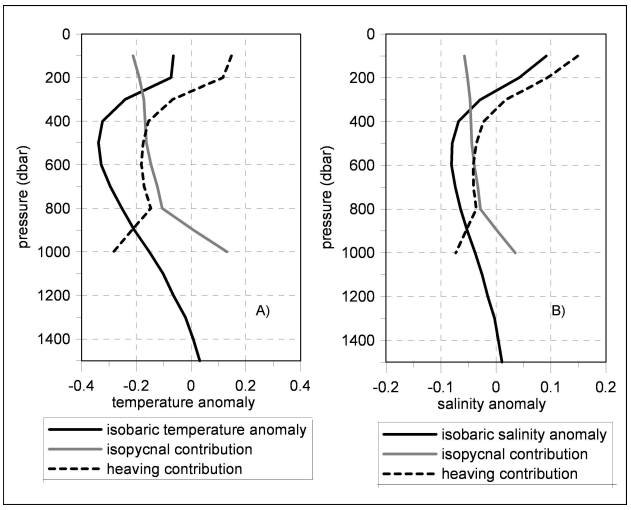


Fig. 2. A) T and B) S anomalies on isobaric surfaces (black line), and their both contributions: isopycnal (grey line) and heaving (dashed black line). These anomalies correspond to 2006 (after the WMT) with the 2004 (before the WMT) profile as reference.

The authors acknowledge the Observatoire de Villefranche sur Mer Service d'Observation for providing the DYFAMED monthly CTD time series (http://www.obs-vlfr.fr/sodyf/home.htm).

References
1 - Gasparini G.P., Ortona A., Budillon G., Astraldi M. and Sansone E., 2005. The effect of the Eastern Mediterranean Transient on the hydrographic characteristics in the Strait of Sicily and in the Tyrrhenian Sea. *Deep-Sea Res. I*, 52 (6): 915–935
2 - CIESM, 2009. Dynamics of Mediterranean deep waters. N° 38 in CIESM Workshop Monographs [F. Briand, Ed.], 132 pages, Monaco.
3 - Bindoff, N.L. and McDougall T.J., 1994. Diagnosing climate change and ocean ventilation using hydrographic data. *J. Phys. Oceanogr*., 24: 1137-1152.
4 - Zunino P., Vargas-Yáñez M., Moya F., García-Martínez M.C. and Plaza F., 2009. Deep and intermediate layer warming in the western Mediterranean: Water mass changes and heaving. *Geophys. Res. Lett.*, 36, L20608, doi:10.1029/2009GL039578,
5 - Schroeder K., Ribotti A., Borghini M., Sorgente R., Perilli A., Gasparini G.P., 2008. An extensive Western Mediterranean Deep Water Renewal between 2004 and 2006. *Geophys. Res. Lett.*, 35, L18605, doi:10.1029/2008GL035146.

WHAT DOES INDUCE TEMPERATURE AND SALINITY CHANGES IN THE WMED ALONG THE SECOND HALF OF THE 20TH CENTURY?

Patricia Zunino [1]*, Manuel Vargas-Yañez [1], M. Carmen García-Martinez [1] and Francina Moya [1]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga, Fuengirola, Spain - pzunino@ma.ieo.es

Abstract
Temperature and salinity evolution in the Western Mediterranean have always been studied on isobaric surfaces. But TS changes on pressure levels can be affected by changes on isopycnal surfaces and due to the vertical displacement of isopycnals (referred to as heaving). Temperature changes induce salinity changes and vice versa. The main objective of this work is to quantify which process dominates TS changes along the second half of the 20th century.
Keywords: Western Mediterranean, Global Change, Time Series

In most of the works carried out in the Western Mediterranean (WMED), temperature and salinity trends have been estimated on isobaric surfaces. It is well known that Western Mediterranean Deep Water has warmed and increased its salinity during the second half of the 20th century [1]. Concerning temperature trend in the intermediate layer, different figures have been provided by different authors, lots of them statistically non significant, even some of them are contradictories [1]. A possible explanation to the previous is that changes on isobaric surfaces have two effect added: changes on material surfaces (related to water mass changes) and those caused by the vertical displacement of isopycnals (related to wind stress curl and formation rate of deep water) [2]. These authors proposed the methodology to evaluate how former effects affect to changes on each pressure level. This methodology has recently been applied for the first time in the WMED [3]. Usually, temperature changes in water mass induce salinity changes and vice versa. Depending whether temperature or salinity induces the change, two different processes have been defined: pure-warming or pure-freshening [2]. Besides, when temperature or salinity changes on pressure levels are produced by the vertical displacement of isopycnals, the process is named pure-heaving [2].

The objective of the present work is to indentify what process dominates different sub periods along the 20th century as an extension of the previous work [3].

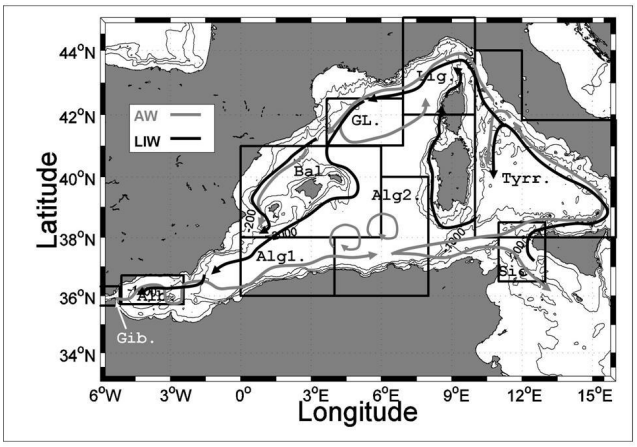


Fig. 1. Map for the Western Mediterranean. Rectangles identify the areas for which MEDAR Group´s [2002] data have been obtained. The final data set is made of averages for the whole WMED. These averages are weighted by the box areas

Salinity and temperature data were extracted from MEDAR database, from 1943 to 2000, and from different selected regions of the WMED (squares in fig. 1). The final data set was made of averages for the whole WMED. Temperature, salinity and density reference profiles were obtained averaging data from 1960 to 1990. We have estimated TS changes on isobaric surfaces and its two different contributions, isopycnal changes and heaving, following the methodology explained in [3]. And finally, the relative strength of each process (pure-warming, pure-freshening and pure-heaving), in terms of percentage variance explained can be estimated solving equations (17) proposed in [2].

Preliminary results show that more than one process coincide explaining the same percentage of variance in a same pressure level and sub period (fig. 2). This is because the equation system has been solved considering that only a single process induces the property change. But, matching processes at each pressure level are not always the same, and this is related to the temperature and salinity vertical gradients and to the magnitude of the TS changes in the different layers of the water column. Indeed, the dominating process in each sub period is related to abrupt temperature and/or salinity changes documented in previous works as well as to intense events of deep water formation.

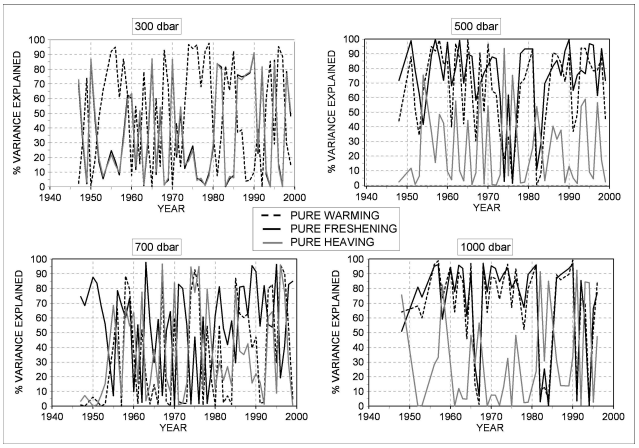


Fig. 2. Percentage variance explained by pure warming (dashed black line), pure freshening (black line) and pure heaving (grey line) for four different pressure levels (300, 500, 700 and 1000 dbar).

References
1 - Vargas-Yañez M., Moya F., Tel E., García-Martínez M.C., Guerber E. and Bourgeon M., 2009. Warming and salting of the Western Mediterranean during the second half of the XX century: Inconsistencies, unknowns and the effect of date processing. *Sci. Mar.*, 73(1): 7-28, doi: 10.3989/scimar.2009.73n1007.
2 - Bindoff N.L. and McDougall T.J., 1994. Diagnosing climate change and ocean ventilation using hydrographic data. *J. Phys. Oceanogr*., 24: 1137-1152.
3 - Zunino, P., Vargas-Yáñez M., Moya F., García-Martínez M.C. and Plaza F., 2009. Deep and intermediate layer warming in the western Mediterranean: Water mass changes and heaving, *Geophys. Res. Lett*., 36, L20608, doi:10.1029/2009GL039578.

DISTRIBUTION DU ΔPCO2 ET DES FLUX AIR-MER DE CO2 DANS LE GOLFE DU LION (MEDITERRANEE OCCIDENTALE)

Nadira Ait-Ameur [1]* and Goyet Catherine [2]

[1] Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral, 16000, Alger, Algérie - Nameur@Gmail.Com

[2] Université de Perpignan via Domitia - Laboratoire IMAGES, 66860, Perpignan, France

Abstract

Ce travail constitue la première description de la distribution du ΔpCO_2 (pCO_2eau-pCO_2air) et des flux air-mer dans les eaux de surface du golfe du Lion au cours des mois de février, mai, juin et septembre 2001. Le rôle de cette zone côtière comme source ou puits de CO_2 pour l'atmosphère est influencé par les apports du Rhône. Le golfe du Lion est en moyenne, sur l'ensemble des campagnes, une faible source de CO_2 pour l'atmosphère (+17,7 mmol/m^2/jour) mais se comporte comme un puits de CO_2 en mai (-3,3 mmol/m^2/jour) et juin (-10,8 mmol/m^2/jour) suite à une forte production primaire conséquente à un enrichissement des eaux de surface en sels nutritifs par les apports du Rhône.

Keywords: Air-Sea Interactions, Carbon, Gulf Of Lions

Introduction

En Méditerranée nord occidentale, généralement considérée comme oligotrophe, les apports fluviaux du Rhône influencent la productivité du golfe du Lion. Le golfe du Lion est caractérisé par un fonctionnement hydrodynamique complexe qui a des répercussions significatives sur le système biogéochimique de la région et sur le cycle du carbone. Les zones côtières et les plateaux continentaux représentent 7% de l'océan global. Étant le lieu de transition entre l'environnement terrestre et océanique, ces zones jouent un rôle tampon recevant directement les perturbations anthropiques. En Méditerranée, les travaux concernant les échanges air-mer de CO_2 sont peu nombreux : le bassin liguro provençal [1], [2], le détroit de Gibraltar [3], et la Mer Egée [4]. Nous proposons donc de présenter dans ce travail une première climatologie de la distribution du ΔpCO_2 et des flux air-mer de CO_2 dans le golfe du Lion et d'évaluer le rôle de cette zone côtière, influencée par les apports anthropiques, comme source ou puits de CO_2 pour l'atmosphère au cours des quatre périodes : février, mai, juin et septembre 2001. Cette étude a été réalisée dans le cadre du programme SARHYGOL (Suivi Automatique Régulier de l'Hydrologie dans le GOlfe du Lion).

Méthodologie

La pression partielle de CO_2 (pCO_2) a été calculée à partir des mesures d'alcalinité totale (AT) et du carbone inorganique dissous (TCO_2) en utilisant les constantes d'équilibre de Goyet et Poisson [6]. Les mesures d'alcalinité (AT) et de TCO_2 ont été réalisées par la méthode de potentiométrie avec une incertitude de +/- 4 µmol/kg. Les flux air-mer de CO_2 (FCO_2 , mmol/m /jour) ont été calculés en utilisant les vitesses moyennes journalière de vents enregistrées à bord au cours de la période d'échantillonnage. Le coefficient d'échange a été calculé selon Wanninkhof [7].

Résultats et discussion

La distribution du ΔpCO_2 (pCO_2eau – pCO_2air), dans la zone d'étude, sur l'ensemble des campagnes, montre une grande variabilité spatiale et temporelle (figure 1). Elle varie de -232 µatm à +91 µatm.

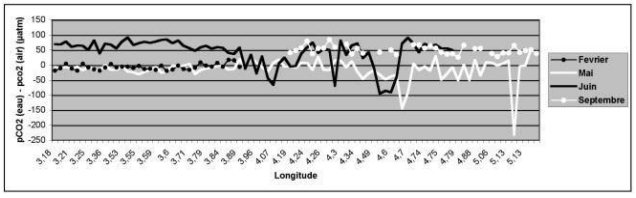


Fig. 1. Distribution du ΔpCO (µatm) des eaux de surface du golfe du Lion en fonction de la longitude pour les mois de février, mai, juin et septembre 2001.

En février, la campagne ne couvre que la partie ouest du golfe du Lion. Pour cette période le ΔpCO_2 varie de -19 à +17 µatm avec une moyenne de 6,8 ± 9 µatm. En février cette partie est principalement en équilibre avec l'atmosphère et se comporte comme une faible source de CO_2 pour l'atmosphère avec un flux moyen net de 0,7 mmol/m^2/jour. En mai, la campagne couvre l'ensemble du golfe du Lion. Pour cette période, le ΔpCO_2 varie de -232 à +52 µatm avec une moyenne de -14 ± 34 µatm. C'est dans la zone côtière située à 4,75°E et 5,13°E de longitude que les plus grands écarts en pCO_2 entre l'eau et l'atmosphère sont observés (respectivement -140µatm et -232 µatm). A cette période les eaux de surface sont un puits de CO_2 pour l'atmosphère (-3,3 mmol/m^2/jour). En juin, le bassin présente aussi une grande variabilité du ΔpCO_2 (-95 à +91 µatm) avec une moyenne de 41±45 µatm et un flux moyen net entrant de -10,8 mmol/m^2/jour. En septembre, la distribution du ΔpCO_2 varie de +25,7 à +84 µatm avec une moyenne de 50±13 µatm. A cette période le golfe du Lion est une source de CO_2 pour l'atmosphère avec un flux net de +54,7 mmol/m^2/jour. L'utilisation de l'équation empirique de Takahashi *et al.* [5] a permis de montrer que pour les campagnes de septembre et février c'est le paramètre « température » et le mélange vertical qui semble contrôler la distribution de la pCO_2 dans les eaux de surface. En revanche il apparaît que pour les périodes de mai et juin c'est le paramètre « Biologie, Production primaire » qui contrôle sa distribution dans la zone côtière. Les fortes sous saturations en CO_2 des eaux de surfaces observées en mai et juin dans la partie est du golfe du Lion sont associées à de très fortes concentrations en chlorophylle « a » qui excèdent les 4 µg/l avec des pics pouvant atteindre 7 µg/l en juin dans la zone côtière. Les apports importants en sels nutritifs par le Rhône enrichissent les eaux de surface (eutrophisation) et favorisent la production primaire qui joue un rôle important dans l'absorption du CO_2 atmosphérique.

Au vu de ces résultats, il apparaît que, dans le golfe du Lion (zone de transition entre le milieu côtier et le milieu océanique), la distribution du ΔpCO_2 est contrôlée par de nombreux processus. Bien qu'il se comporte, sur l'ensemble des périodes étudiées, comme une source de CO_2 pour l'atmosphère avec un flux moyen net de +17,7 mmol/m^2/jour, il reste néanmoins un puits non négligeable pour les mois de mai et juin pour lesquels la distribution du ΔpCO_2 est contrôlée par le phytoplancton dont la productivité (nous supposons) est accrue par les apports du Rhône en sels nutritifs. Un échantillonnage saisonnier plus exhaustif nous permettrait de connaître plus précisément le rôle puits ou source de CO_2 du golfe du Lion à l'échelle annuelle.

References

1 - Bégovic, M., Copin-Montégut, C., (2002). Processes controling annual variations in the partial pressure of CO_2 in surface waters of the central northwestern Mediterranean Sea (Dyfamed site). *Deep-Sea Research II*, 49 (11): 2031-2047.

2 - Mémery, L., Lévy, M., Vérant, S., Merlivat L., (2002). The relevant time scales in estimating the air–sea CO_2 exchange in a mid-latitude region. *Deep Sea Research Part II: Topical Studies in Oceanography*, 49 (11): 2067-2092.

3 - Aït-Ameur, N., Goyet C., (2006). Distribution and transport of natural and anthropogenic CO_2 in the Gulf of Cadiz. *Deep Sea Research Part II: Topical Studies in Oceanography*, 53 (11-13): 1329-1343.

4 - Karasakopoulou, E., Rapsomanikis, S., Papadopoulos, A., Papathanassiou, E., (2009). Partial pressure and air-sea CO_2 flux in the Aegean Sea during February 2006. *Continental Shelf research*, 29:1477-1488.

5 - Takahashi, T., Sutherland, S.C., Sweeney, C., Poisson, A., Metzl, N., Tillbrook, B., Bates, N., Wanninkhof, R., Feely, R.A., Sabine, C., Olafsson, J., Nojiri, Y., (2002). Global sea-air CO_2 flux based on climatological surface ocean pCO_2, and Seasonal Biological and Temperature Effects. *Deep Sea Research Part II: Topical Studies in Oceanography*, 49 (9-10): 1601-1622.

6 - Goyet, C., et Poisson, A., New Determination of Carbonic Acid Dissociation Constants in Seawater as a Function of Temperature and Salinity, (1989). *Deep Sea Research Part A. Oceanographic Research Papers 36.11 1635-54.*

7 - Wanninkhof, R. (1992). Relationship between Wind Speed and Gas Exchange over the Ocean. *Journal of Geophysical Research* 97: 7373-83.

BIOACCUMULATION OF HEAVY METALS BY THE BROWN ALGA *CYSTOSEIRA* SP. ALONG THE TURKISH COAST OF THE AEGEAN SEA

Idil Akcali [1] and Filiz Kucuksezgin [1]*

[1] Dokuz Eylul University Institute of Marine Sciences & Technology - filiz.ksezgin@deu.edu.tr

Abstract

Brown algae *Cystoseira* sp. and to gain additional information on the environmental conditions of the area seawater samples were collected from six sampling stations along the Turkish coast of the Aegean Sea. Concentrations of Cd, Pb, Cu, Zn, Mn and Fe were measured for both algae and seawater samples. The heavy metal concentrations detected in algae showed significant differences among all stations. The data obtained from this study were also compared with those obtained from previous studies. Metal concentrations recorded at the stations may be used for background levels for interspecific comparison within the Aegean area.

Keywords: Bio-Accumulation, Metals, Aegean Sea

Introduction

Heavy metals, reaching the marine environment directly or indirectly, are dangerous pollutants which can effect human health. Determination of metal concentration in an area is important to provide information about the levels of metal contamination and environmental quality. On that basis macroalgae have been used as biomonitors of heavy metal pollution in marine environment because they have high accumulation capacity, bind only free metal ions, represent the metal concentration of their locality quite well and they are widely distributed [1,2]. Brown algae have high metal accumulation capacity from surrounding water and they are good indicators of their environment because they are physiologically unable to regulate the uptake of trace elements [3,4]. *Cystoseira* species were used in this study because of these characteristics of the phylum and because they widespread along the coast of the Aegean Sea.

Materials and Methods

The *Cystoseira* sp. and water samples were collected in six stations in April, 2006 from the Northern (Çanakkale), Middle (Izmir) and the Southern (Marmaris – Mugla) parts of the Aegean coast. Three subsamples of each macroalgae sample (approximately 1 g dry weight) were digested in microwave digestion system with acid mixture solution. The water samples were collected in preconditioned polyethylene bottles. Ion exchange technique, using Chelex-100 resin was applied for heavy metals in water samples [5]. All the analyses were performed by Varian atomic absorption spectrophotometer [6].

Results and Discussion

Metal concentrations in *Cystoseira* decreased in the order Pb<Cd<Cu<Zn<Mn<Fe; in seawater the sequence was Pb<Cd<Cu<Mn<Zn <Fe. The highest levels for all metals in *Cystoseira* were measured in Marmaris region except Cd and Pb. There were positive correlations in *Cystoseira* sp. between Cd-Zn, Cd-Fe, Cu-Zn, Cu-Mn, Cu-Fe, Zn-Mn, Zn-Fe and Mn-Fe (Spearman correlation coefficient, $p<0.05$). Pb and Cu concentrations in the alga were positively correlated with the respective concentrations in the seawater. Cd, Pb, Cu, Zn and Mn concentrations in *Cystoseira* sp. were lower than those from other areas [7,8,9].

References

1 - Conti M.E.and Cecchetti G., 2003. A biomonitoring study: trace metals in algae and molluscs from Tyrrhenian coastal areas. *Environmental Research*. (93): 99-112.

2 - Rainbow P.S., 1995. Biomonitoring of heavy metal availability in the marine environment. *Marine Pollution Bull*., 8(1): 16-19.

3 - Davis T. A., Volesky B. and Mucci A., 2003. A review of the biochemistry of heavy metal biosorption by brown algae. *Water Research*, 37 (18): 4311-4330.

4 - Ostapczuk P., Burow M., May K., Mohl C., Froning M., Süßenbach B., Waidmann E. and Emons H., 1997. Mussels and algae as bioindicators for long-term tendencies of element pollution in marine ecosystems. *Chemosphere*, 34: 2049-2058.

5 - Dornfner K., 1972. Ion Exchange; Proportion and Applications. Ann Arbor Science. Michigan.

6 - UNEP. 1985. Reference Methods for Marine Pollution Studies. No:26.

7 - Sawidis T., Brown M.T., Zachariadis G., Sratis I., 2001. Trace metal concentrations in marine algae from different biotopes in the Aegean Sea. *Environment International*, 27: 43-47.

8 - Topcuoglu S., Güven K.C., Balkis N., Kirbasoglu Ç., 2003. Heavy metal monitoring of marine algae from the Turkish Coast of the Black Sea. *Chemosphere*, 52: 1683-1688.

9 - Olgunoglu M.P.P., Polat S., 2007. Seasonal changes of heavy metals in two macroalgae species [Cystoseira corniculata (Phaeophyta), Laurencia papillosa (Rhodophyta)] in the Iskenderun Bay, (in Turkish). *E.U. Journal of Fisheries&Aquatic Sciences*, 24(1-2): 25-30.

^{210}PO, ^{210}PB, ^{137}CS AND HEAVY METAL CONCENTRATIONS IN MUSSELS, FISH SPECIES, SEDIMENTS AND SEA WATER IN DIDIM, TURKISH COAST OF AEGEAN SEA

S. Aközcan [1], A. Ugur [1], G. Yener [1], B. Özden [1]*, E. Aslan [1] and I. Filizok [1]
[1] Ege University, Institute of Nuclear Sciences - banu.ozden@ege.edu.tr

Abstract

Intense agricultural activities with dense use of fertilizers and Menderes river and streams carrying industrial and agricultural residues into the sea cause additional pollution in Didim region. In this study, concentrations of ^{210}Po, ^{210}Pb, ^{137}Cs and heavy metals (Zn, Cu, Fe, Cd, Mn, Ni, Pb, Cr) have been measured in mussels (*Mytilus galloprovincialis*), sediments, fish species and sea water collected from Didim (Aegean Sea) monthly.

Keywords: Aegean Sea, Bio-Indicators, Pollution, Radionuclides, Metals

^{210}Pb ($t_{1/2}$ = 22 years) and ^{210}Po ($t_{1/2}$ = 138 days) are decay products of ^{238}U, and their main source in the environment is atmospheric radon. Both radioisotopes have a strong affinity for particles, but have different binding mechanisms. ^{210}Pb adsorbs on particle surfaces whereas ^{210}Po is considered as an important source of the natural radiation received internally by marine organisms [1,2]. The main source of ^{137}Cs in marine environment can be attributed to worldwide fallout deposition from atmospheric nuclear weapons testing (1941-1981) [3]. In the literature, there is no data for ^{137}Cs for Didim coastal area. Most of the particle-reactive radionuclides released into the aqueous phase eventually reach the sediments. The accumulation, retention and transport of particle reactive radionuclides is strongly associated with sediment and sedimenting particles [4]. Marine organisms are commonly used as environmental matrices in chemical and radioactive monitoring programmes because they accumulate persistent pollutants at concentrations orders of magnitude above those in the water [5]. In our project supported by IAEA, there were significant differences in ^{210}Po and^{210}Pb concentrations in mussel samples due to the stations. Therefore, this research has been emphasized on Didim station which is located on the western coast of Turkey and indicated in Figure 1. ^{210}Po, ^{210}Pb, ^{137}Cs and heavy metals (Zn, Cu, Fe, Cd, Mn, Ni, Pb, Cr) concentrations of marine samples are measured monthly to determine the sources of marine pollution in this area. For mussel (*Mytilus galloprovincialis*) samples and fish species, in order to minimize the effect that size (age) exerts on the radionuclide concentrations; specimens of standard size in groups were selected. Sediment samples were taken by bottom-grap. Each sample is oven-dried to constant weight and was sieved before analysis. After applying chemical procedure with some acids, polonium was spontaneously plated onto a copper discs. Measurements of ^{210}Po were realized through its 5.30 MeV alpha particle emission, using ^{209}Po (4.88 MeV alpha emission, $t_{1/2}$ = 109 a) as the internal tracer [6,7]. ^{210}Po was measured by alpha spectrometry using a Passivated Implanted Planar Silicon detector (Ortec Octete Plus PIPS detector). The samples were then stored at least 6 months to allow decay of ^{210}Pb and subsequent radioactive growth of ^{210}Po. The ^{210}Pb activity was calculated from the ingrowth of ^{210}Po, assuming zero initial ^{210}Po activity. ^{137}Cs concentrations were measured by HPGe dedector (model of Tennelec, 184 cm^3 p-type coaxial). Heavy metal concentrations (Zn, Cu, Fe, Cd, Mn, Ni, Pb, Cr) were measured by ICP-OES (Perkin-Elmer 2000 DV). Concentrations of ^{210}Po and ^{210}Pb in mussels were in the range of 34±9 and 2303±383 Bq kg^{-1} (dry weight); non-dedectable and 64±6 Bq kg^{-1} (dry weight), respectively. Among the fishes, small pelagic plantkton feeding fish like sardine (*Sardine pilchardus*) tend to accumulate more ^{210}Po. ^{210}Po and ^{210}Pb concentrations in the sediment samples varied between 24±5 and 126±6 Bq kg^{-1}; 18±3 and 59±4 Bq kg^{-1}. The values of Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn in mussel, sediment and fish (except Cd in fish) samples found lower than the acceptable limits. The levels of ^{137}Cs concentrations in mussels, sediment , fish species and sea water samples were found relatively low.



Fig. 1. The map of sampling location.

References

1 - Cochran J.K., and Masqué, P., 2003, Short-lived U/Th series radionuclides in the ocean: tracers for scavenging rates, export fluxes and particle dynamics, *Reviews in Mineralogy and Geochemistry*, 52, pp. 461–492.

2 - Fisher N.S., Burns K.A., Cherry R.D., and Heyraud M., 1983, Accumulation and cellular distribution of ^{241}Am, ^{210}Po and ^{210}Pb in two marine algae, *Marine Ecology Progress Series*, 11, pp. 233–237.

3 - Hamilton, T.F., 2004, Linking legacies of the cold war to arrival of anthropogenic radionuclides in the oceans through the 20th Century, Livingston, H.D. (Ed.), Marine Radioactivity, 6, Radioactivity in the Environment, Elsevier Science, Amsterdam, pp. 30–87.

4 - Ugur, A., Yener, G., and Bassari, A., 2002, Trace metals and ^{210}Po(^{210}Pb) concentrations in mussels (Mytilus galloprovincialis) consumed at western Anatolia, Applied Radiation and Isotopes, 57, 565-571.

5 - Beiras R., Bellas J., Fernández N., Lorenzo J.I., and Cobelo-García A., 2003, Assessment of coastal marine pollution in Galicia (NW Iberian Peninsula); metal concentrations in seawater, sediments and mussels (Mytilus galloprovincialis) versus embryo–larval bioassays using Paracentrotus lividus and Ciona intestinalis, *Marine Environmental Research*, 56, 4, pp. 531-553.

6 - Flynn W.W., 1968, The Determination of Low Levels of Polonium-210 in Environmental Materials. *Anal. Chim. Acta*., 43, 221-227.

7 - Ugur, A., 1998, Gökova Körfezi Deniz Sediment Korlarinda Radyoaktif Pb, Po, Ra, Cs, Am ve Pu Izotoplarinin Dagiliminin Incelenmesi, Sediment Hizi ve Tarihleme Çalismalarinda Kullanilmasi, E.Ü. Fen Bil. Nükleer Bil. ABD, Doktora Tezi.

DETERMINATION OF HEAVY METALS IN FISH SAMPLES FROM TRABZON COAST OF THE EASTERN BLACK SEA

Nigar Alkan [1]*, Ali Alkan [2] and Muammer Aktas [2]
[1] Central Fisheries Research Institute Trabzon / Turkey
[2] Karadeniz Technical University, Faculty of Marine Sci, Çamburnu, Trabzon-Turkey - anigar@gmail.com

Abstract
In the present study, concentration of heavy metals (Cu, Cd, Fe, Mn, Pb, Zn) were determined in the two different demersal (benthic) fish species of red mullet (*Mullus barbatus ponticus*) and whiting (*Merlangius merlangus euxinus*). Samples were collected from the two stations in the Black Sea. One of the stations is Sürmene Bay and the other is Yomra Bay in Trabzon-Türkiye. The concentrations of metals (Cu, Cd and Pb) were determined by using GFAAS, Zn, Fe, and Mn by using FAAS.
Keywords: Black Sea, Demersal, Bio-Accumulation

Introduction
The pollution of the aquatic environment with heavy metals has become a worldwide problem during recent years, because they are indestructible and most of them have toxic effects on organisms [1]. The eastern Turkish Black Sea coast is not an industrialized area, and the agricultural activities are greater in the eastern region than along the western Black Sea coast. Such activities involve, the application of pesticides and artificial fertilizers in widely diversified habitat, including agricultural croplands, and hazelnut and tea plantations [2]. Different aquatic organisms often respond to external contamination in different ways, where the quantity and form of the element in water, sediment, or food will determine the degree of accumulation. Contaminants in the sediment are taken up by benthic organisms in a process called bioaccumulation. When larger animals feed on these contaminated organisms, the toxins are taken into their bodies, moving up the food chain in increasing concentrations in a process known as biomagnifications. As a result, fish and shellfish, waterfowl, and freshwater and marine mammals may accumulate hazardous concentrations of toxic chemicals [3].

Material and Method
The size of the fish collected varied in November 2009, depending on the species, between 11 cm and 22 cm, and their age was from 4 to 1.5 cm years. The separated fish were put in petri dishes to dry at 105 ^{0}C until reaching a constant weight. Dried fish were placed into digestion flasks and ultra pure concentration HNO_3 and H_2O_2 (7:1 v/v) was added. The digestion flaks were heated to 200 ^{0}C until dissolution. The temperature control microwave heating device was used for digestion of the dried fish meat for determination the metals with spectroscopic methods. After dissolution diluted with water and analyzed for heavy metal concentration using atomic absorption spectrometer [4].

Results and Discussion
Heavy metal concentrations determined in the fish samples same length groups from the two different regions. Cu, Cd, Fe, Mn, Pb, Zn analyses results are given in Table 1. Region differences are observed Fe and Mn in the first group whiting and Zn in the third group whiting. Cd concentrations are differences all off group whitings and Pb concentration in the first and second group whitings are considered significant. Except Pb, all metal concentrations in the red mullet samples from Sürmene and Yomra Bay are not determined differences($p>0.05$).

Tab. 1. Heavy metal concentrations (µg/g dry wt) in whiting and red mullet samples

Fish	Station	Total Lenght (cm)	Total Weight (g)	Fe (mg/L)	Mn (mg/L)	Zn (mg/L)	Cu (µg/L)	Cd (µg/L)	Pb (µg/L)
Whiting 1	Sürmene	20.94±0.82	74.19±9.21	11.19±0.80	0.94±0.12	15.78±0.45	384±34	49.47±3.49	10.26±0.67
	Yomra	19.60±1.29	64.79±11.19	7.48±0.79	0.20±0.07	16.33±0.50	432±78	11.87±0.89	6.27±0.16
Whiting 2	Sürmene	15.42±0.34	27.49±2.07	6.15±1.17	0.69±0.23	15.46±0.39	539±33	64.13±0.84	11.61±2.90
	Yomra	14.93±0.67	24.83±3.65	9.06±1.53	0.86±0.19	15.82±0.51	542±63	23.52±0.81	4.56±1.06
Whiting 3	Sürmene	13.70±0.89	17.65±2.47	13.71±2.06	0.79±0.14	16.99±0.67	510±42	77.82±0.97	11.79±3.83
	Yomra	12.50±0.61	13.05±1.46	10.04±2.47	1.19±0.18	15.04±0.53	552±32	68.64±2.94	4.24±3.04
Red mullet	Sürmene	12.67±0.71	20.20±3.50	19.80±1.50	1.09±0.23	15.54±2.02	506±6	33.54±1.86	4.52±0.28
;	Yomra	11.43±0.35	15.39±1.41	23.22±1.60	1.18±0.44	17.47±0.28	626±8	29.59±1.28	2.78±0.61

References
1 - MacFerlane, G. B., Burchettt, M. D., 2000. Cellular Distribution of Cu, Pb and Zn in the Grey Mangrove Avicemnia Marina (Forsk). *Vierch Aquatic Botanic*, 68: 45- 59.
2 - Ergül, H. A., Topcuoglu, s., Ölmez, E., Kirbasoglu, Ç., 2008. Heavy Metals in Sinking Particles and Battom Sediments from Eastern Turkish Coast of the Black Sea. Estuarine, *Coastal and Self Science*.: 1-7.
3 - Begum, A., S, H., Khan.I., 2009. Analysis of Heavy Metals in Waters, Sediments and Fish Samples of Madivala Lakes of Bangalore, Karvnataka. International *Journal of Chemtech Research*. pp: 245- 249.
4 - Milestone Digestion Aplication Note DG- FO- 17.

COMPOSITION, SPATIAL VARIABILITY AND SOURCES OF SEDIMENT PAHS IN TWO NEIGHBORING AQUATIC ENVIRONMENTS

Bedri Alpar [1]* and Selma Ünlü [1]

[1] Istanbul University, Institute of Marine Sciences and Management - bedrialpar@gmail.com

Abstract

The distribution, composition and sources of PAH mixtures in the sediments of the Gulf of Gemlik, sea of Marmara, and in a freshwater lake at its eastern extension, indicate characteristic spatial variability depending on various anthropogenic inputs. While atmospheric inputs are similar for both cases, other contributions are related to the spatial characteristics of riverine and terrestrial inputs and other activities such as shipping, fishing and agriculture. On the basis of several diagnostic criteria and principal component analysis -multiple regression models used to assess the type of process through which PAHs were generated, pyrogenic origin is dominant, even petrogenic PAHs also occur in combination with pyrogenic PAHs.

Keywords: Pah, Sediments, Pollution, Marmara Sea

Introduction:

Polycyclic aromatic hydrocarbons (PAHs), a group of particle-reactive hydrophobic organic chemicals, are deposited in aquatic sediments from a variety of sources. Their importance as an environmental hazard derives from their potential carcinogenic and mutagenic properties. Lower-molecular-weight PAHs, which may be acutely toxic, are less strongly adsorbed compared with the heavier species. PAHs migrate towards bottom sediments due to their extremely low solubility in water, so that sediments are the best media in evaluation of PAH impacts to aquatic environments.

Although it is not routinely applicable, PAH ratios, molecular indices and principal component analysis (PCA)-multiple regression models can be used in delineating the origin of sediment PAHs; natural or anthropogenic. Worldwide data may be helpful in understanding of their source apportionment. In the present study, evaluation of the sediment PAHs in the Gulf of Gemlik, SE part of the Sea of Marmara, and in Lake Iznik, a freshwater lake at its eastern extension, provides baseline information for hydrocarbon origin in the sediments of these two different aquatic environments.

Experimental details:

Before extraction, the surface samples (upper 5 cm) from the Gulf of Gemlik [1] and Lake Iznik [2] were thawed and homogenized until textural and color homogeneity was achieved. The concentrated extract was analyzed by gas chromatography/mass spectrometry (GC/MS), which is enable the identification of organic compounds presented at very low concentrations and in complex mixtures. The system was calibrated for the 12 priority pollutant PAHs using the internal standard calibration procedure described in US EPA method 8000. The method detection limits for Phe, Ant, Flu, Py, B[a]A, Ch were at the order of 1.0 ng/g dry sediment, while they were around 0.1 ng/g for other PAH compounds.

Results:

The sediment PAHs in both of the aquatic environments are closely related to the spatial variability of riverine and terrestrial inputs and other activities such as shipping, fishing and agriculture. Atmospheric inputs contributed for both cases, due to heating with coal, petroleum coke particles and biomass burning from various sources. The majority of sedimentary PAHs indicate pyrogenic origin, even though petrogenic PAHs do also occur in combination with pyrogenic PAHs. Eastern and southern shores of the Gulf of Gemlik were contaminated with higher-molecular-weight PAHs. The diagnostic ratios of Ph/Ant, B[a]P/(B[a]P+B[e]P) and IP/(IP+B[ghi]P) were found relatively more useful in source identification for the study areas. BaA/228 provides a useful tool for distinguishing pyrolytic PAHs, which are generated by incomplete combustion of petroleum, coal, and biomass as in the cases of industrial usage and household heating and cooking. The ratios of Phe/Ant, Ch/B[a]A, Ant/178 and IP/(IP+B[ghi]P) represent decisive differences between two basins while no diagnostic ratios are sensitive sufficiently to the sediment type, possibly due to rapid anthropogenic contamination.

Regarding the diagnostic power of PAH ratios and PCA-multiple regression models, three PAH origins were described; a) severe anthropogenic inputs with pyrolitic and petrogenic mixed pattern, b) pyrolytic and slightly petrogenic inputs, c) pyrolytic atmospheric inputs. The first factor is responsible for 52.5% of the total variance and attributed to composite sources of unburned petroleum and coal combustion. It is in agreement with the elevated-PAH concentrations mainly occurred due to sea port activities and river transportation. The second factor is responsible for 15.8% of the total variance and attributed to the inputs due to burned petroleum and liquid fossil fuel oil combustion (e.g. vehicular engine emission, gasoline and diesel). It is dominated along the southern half of the gulf where marine transportation is heavy. The last factor, weighted in B[a]P, B[ghi]P and IP, is responsible for 10.3% of the total variance. It can be considered as indicator for strongly pyrolytic and atmospheric inputs of petroleum combustion (heating with coal, petroleum coke particles) and biomass burning from various sources (wood, soot, grass and dried dung). It is dominant throughout the Lake Iznik as well as along the northern coastal water of the Gulf of Gemlik.

References

1 - Unlu S. and Alpar B. 2006. Distribution and sources of hydrocarbons in surface sediments of Gemlik Bay (Marmara Sea, Turkey). *Chem.*, 64: 764–777.

2 - Ozturk K., Unlu S., Alpar, B. and Vardar D. 2007. Hydrocarbon pollution in sediments from Lake Iznik (Turkey), determined by fluorescence technique. European Geosciences Union, Geophysical Research Abstracts, 9, EGU2007-A-03882.

CHEMICAL CONTAMINATION OF WESTERN COASTAL MEDITERRANEAN WATERS: THE MYTILOS PROJECT

Bruno Andral [1]*, François Galgani [1] and Corinne Tomasino [1]
[1] IFREMER - bruno.andral@ifremer.fr

Abstract

The MYTILOS project aimed to draw up a preliminary report on coastal chemical contamination on a Western Mediterranean scale (continental coasts , Balearic Islands, Sicily, Sardinia, Corsica and Maghreb), on the basis of transplanted mussel methodology. MYTILOS project allowed to identify background levels between the differents sub-basin and contaminated sectors. The most highly-impacted zones were mainly situated adjacent to urban and industrial centers and the outlets of major rivers. On a global scale we can observe that the levels in the Mediterranean Sea are in the same range than other area worldwide. Main differencies are concerning the maximum values that are related to local high contamination.

Keywords: Monitoring, Bio-Accumulation, Chemical Analysis

Most monitoring programmes now include the use of biological indicators (1). This is based on the assumption that levels of trace contaminants accumulated in biological tissues represent the time and space integrated value of these contaminants in the surrounding waters. In the Mediterranean Sea, the specie *Mytilus galloprovincialis* is widespread, but in some locations natural populations are rare or absent. The transplantation method compensated this scarcity and allows controlling the source, age, and stage of sexual maturity of the samples (2). MYTILOS project has backed by the INTERREG III B / MEDOC programme, steered by Ifremer and backed by Toulon Var Technologies, in cooperation with the ICRAM, IEO, PSTS, IMEDEA, CSIC, Catalan water agency, INSTM, ISMAL, INRH and University of Agadir, MYTILOS has also backed by the PNUE/PAM - MEDPOL. Tree cruises (2004, 2005, 2006) deployed 149 stations during 3 month, between march and july along Western Mediterranean shores. A total of 124 stations were retrieved (82.5 %). All the results are expressed by mg or µg/kg dry weight of flesh. The distribution of lead was relatively homogenous, with a median value of 1.17mg/kg. However, two sites were pinpointed as being particularly impacted by lead: the Portoscuso industrial site in Sardinia , with a maximum of 8.25 mg/kg and the zone spanning Portman to El Portus in spain from 5.3 to 6.25 mg/kg which was home to a thriving mining industry during the period of 1960-1990. Levels of cadmium were globally homogenous throughout stations, with a median of 1.28 mg /kg. A few stations showed relative peaks of around 2 mg/kg: Filicudi and Ustica stations in Sicily, Aguilas and Adra in Spain. Several sites impacted by mercury were recorded: first and foremost the Portoscuso site, with a maximum level of 0.31 mg/kg, witnessing significant contamination generated by a large industrial complex. Concentrations of nickel were around 1.1 mg / kg. Extreme values were found in some sampling sites in Sud West sub basin especially in Tunisia (Tabarka [3.18 mg/kg]) and, Algeria (Oued Zhor [2.89 mg/ kg]). The median value of the sum of DDTs compounds was 3 µg/kg.Significant peaks were recorded in the North West and Tyrrhenian sub-basin specially in front of Marseille (15.47 µg/ kg), Barcelone (15.17 g/ kg) and Napoli (15.34µg/ kg). Algiers also showed a high level (10.23µg/ kg) equivalent to the overall levels recorded at stations in front of the following rivers: Ebre, Rhône and Tevere. Regarding the sum of the 10 congeners of PCBs, the distribution show a similar profile. The median value of the sum of PCBs compounds was 8,98µg/kg.

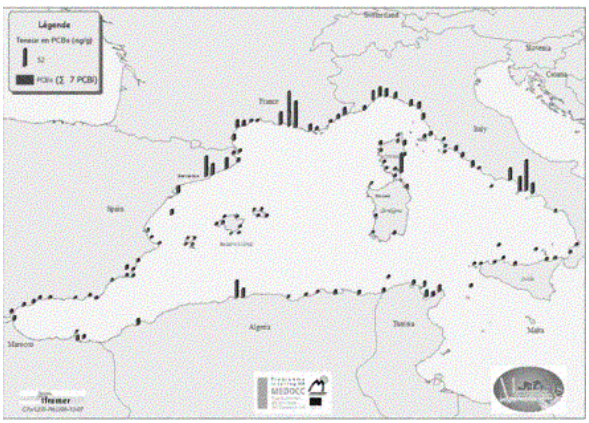


Fig. 1. PCB in mussels (∑PCBi ng.g^{-1} dry weight)

The results show the presence of sites impacted by PCBs, in Barcelona (63.87µg / kg), Marseille (103.52µg / kg), Napoli (91.48µg / kg) and Algiers (51.13µg / kg). This characteristic presence off the coast of major urban centres is further confirmed by values obtained in Sardinia at La Madalena (58.49µg / kg), situated adjacent to a major naval base.

Results relating to the sum of the 16 dosed molecules for PAH showed a median value of 44.4µg/kg. Two peaks have been identified at Marseille (105.5µg/kg) and Piombino in Italy (80.8µg/kg), adjacent to a large industrial complex. On the campaign scale, all measured contaminants showed equivalent levels to those recorded by the RINBIO network (2). This similarity related to both highest levels and background noise recorded at the 124 study stations. This method is also valuable in that it makes it possible to confront the data to that available on *Mytilus galloprovincialis* and *Mytilus edulis* while respecting equivalent biometric criteria. Comparison of these findings with data from the National Observation Network of the water quality on French coasts. Comparison of data among differents studies , however, are generally complicated by subtancials changes that have been made in the analytical methods, saisonnality of sampling, number of congener for the organic compound and must be exercised with caution. On a global scale we can observe that the levels in the mediterranean sea are in the same range than other area worldwide.

Tab. 1. Baseline for Mytilos project, RINBIO , RNO network and worldwide data (in mg or µg/kg dry weight).

Location	Year	Species	Data	Pb (µg.g-1)	Cd (µg.g-1)	Hg (µg.g-1)	Ni (µg.g-1)	DDT (ng.g-1)	DDTs (ng.g-1)	CB 153 (ng.g-1)	PCBs (ng.g-1)	Fluo (ng.g-1)	PAHs (ng.g-1)	Reference
West Mediterranean coast	2004-2006	Transplanted Mussel	Median	1,17	1,29	0,09	0,94	0,5	3	2,2	8,98	1,75	44,4	This study
			Min	0,5	0,24	0,05	0,62	0,5	1,5	0,5	1,53	0,5	21,9	
			Max	8,25	2,11	0,3	3,18	6	19,5	41,3	193,8	16	198,5	
French mediterranean coast	2006	Transplanted Mussel	Median	1,07	0,88	0,07	0,93	0,50	6,60	4,04	12,46	2,10	33,05	Andral 2007
			Min	0,28	0,4	0,02	0,47	0,50	1,50	0,50	1,47	0,50	11,50	
			Max	8,44	2,67	0,23	2,49	5,40	76,37*	44,30	126,74	12,30	92,30	
French mediterranean coast	1995-1999	Mussel	Mean	1,0	0,72	0,12	1,48		18,1	11,7		13,2		RNO 2006
			Min	0,1	0,2	0,04	0,47		1,57	1,57		2,19		
			Max		10	0,60	8,41		83,2**	593		243		
French atlantic chanel coast	1995-1999	Mussel	Mean	1,4	0,6	0,12	1,55		5,3	19,4		21,4		RNO 2006
			Min	0,4	0,17	0,03	0,48		0,63	0,16		4		
			Max	9,6	3,03	0,53	6		34,6	495		245		
North Sea	1993	Mussel	Median	2,55	0,66	0,21	4			48		56		Boreman 1993
			Min	1,0	0,3	0,1	2			12		20		
			Max	4,3	1,69	0,39	10			199,1		874		
Baltic Sea	1997	Mussel	Mean	2	2,13	0,131	1,0							Szefer 2002
USA	2003	Mussels and oyster	Median	0,935	3,37	0,062	2,16	0,499		2,928		19,35		NOAA National status
			Low level	<0,86	<2,186	<0,088	<1,39	<0,14		<0,30		<1,778		
			High level	>1,9035	>4,334	>0,166	>4,70	>7,18		>35,20		>190,69		
California	2004-2005	Mussel	Min	0,46	0,59	0,04	0,54		2		4,4		63	Kimbrough et al 2008
			Max	8,8	8,4	0,24	9,2		820		642		4424	
China	2001	Mussel	Min	0,46	0,40		1,3	9,77	14		1,34	10,3		Fung et al 2004
			Max	2,93	5,31		4,78	330	640		13	392,4		
Australia	1993	Mussel	Mean		1,13	0,07								Haynes 1995
			Min		0,7	0,02								

References

1 - 1Goldberg, E.D. (1975). The Mussel Watch. *Mar. Pollut. Bull.* 6 , 111.
2 - Andral B., Stanisière J-Y., Damier E., Thébault H., Galgani F., Boissery P. ,2004. Monitoring chemical contamination levels in the Mediterranean based on the use of mussel caging. *Marine Pollution Bulletin* 49 : 704-712

THE MODULATION OF RETINOIC ACID SIGNALLING PATHWAYS BY ENVIRONMENTAL POLLUTANTS IN MARINE METAZOANS

A. Antunes [1]*, P. Siby [1], R. R Da Fonseca [1], M. Armanda Reis-Henriques [2], V. Vasconcelos [3], L. F C Castro [1] and M. M Santos [1]
[1] CIMAR/CIIMAR, Centro Interdisciplinar de Investigação Marinha e Ambiental, University of Porto, Rua dos Bragas, 177; 4050-123 Porto, Portugal - aantunes@ncifcrf.gov
[2] Instituto Ciências Biomédicas Abel Salazar (ICBAS), University of Porto, Portugal
[3] Departamento de Biologia, Faculdade de Ciências, University of Porto, Portugal

Abstract
Nuclear receptors (NRs) form a superfamily of ligand-dependent transcription factors in metazoans, where they regulate many biological functions (e.g. reproduction, development and homeostasis). NRs can be modified by anthropogenic contaminants, which can cause cancer and endocrine disruption in humans and wildlife. Marine organisms disturbed by endocrine disrupting chemicals, can have reduced testicular development and fertility, masculinization of female specimens (imposex), etc. In this context, we evaluated the genetic characterization of the retinoid X receptor (RXR) in varied metazoan species (from invertebrates to vertebrates), and we modulated RXR 3D structures to predict the binding affinity of environmental pollutants, obtaining insight into the resilience of RXRs in marine organisms to the effects of endocrine disrupters.
Keywords: Genetics, Biodiversity, Pollution

The study of biological systems in atomic detail is a multidisciplinary field combining knowledge from sciences such as Mathematics, Physics, Chemistry, Biochemistry, Biology and Informatics. It as been previously used with great success to understand enzymatic mechanisms, to predict the binding free energy of two molecules, and in the design of new drugs based on structural information. Although this approach may have the availability to predict if a pollutant may activate a hormone receptors or interfere with the enzymatic activities of an organisms, it has not been a common approach in risk assessment studies of aquatic contaminants, despite it potential great utility in Ecotoxicology. Moreover, integrative efforts using state-of-the-art methodologies at the gene-level (comparative genomics) and protein-level (comparative proteomics) may be the ultimate bridge between structural biology and molecular evolution [1]. The evolutionary study of the RXR protein across a wide range of metazoans (from invertebrates to vertebrates) is important to reveal how mutations have accumulated in this functional constrained protein over millions of years of evolution. The understanding of such genetic basis can provide fundamental biological insight about protein evolution and ecological fitness [2, 3].

In this study, we have retrieved RXR sequences from 57 metazoan organisms (invertebrates and vertebrates) and we have performed a detailed search for selection signatures. First, we have used single-site analyses for detecting selection at the gene level [1].
However, these analyses may be biased against even moderately conservative proteins because the primary criterion involves a comparison of nonsynonymous and synonymous substitution rates, not allowing for the possibility that adaptation may come in the form of very few amino acid changes [1].
Second, we have additionally used powerful statistical methods at the protein-level considering the nature of the amino acid change ("conservative" or "radical" depending on the magnitude of the physicochemical difference between amino-acids, and the physical location of amino-acid sites in the three-dimensional (3D) protein structure [1].
Finally, third, we have determined the 3D structure of several RXRs, using homology-modeling [4], a reliable technique to computationally infer an unknown protein 3D-structure (>50% amino-acid identity) based on the experimentally determined 3D-structure of a related protein [e.g. Human and Biomphalaria (mollusc) RXR crystal structures].

We identified several aminoacids that seem to be essential to RXR activation by organotins and methoprene acid, and therefore, will allow the future identification of potential environmental pollutants RXR agonists based on their conformational characteristics. Typically, RXR ligands contain a carboxylate group, which is important in their ability to be buried stably in the predominantly hydrophobic pocket. This functional group is involved in an ionic interaction with the strictly conserved basic residue of R316 of helix H5 and forms a hydrogen bond with the backbone carbonyl amide group of the β-turn residue A327. Although tributyltin (TBT), a widespread marine contaminant, bind RXR with high specificity and induce RXR activation (similarly to the natural ligand 9-cis retinoic acid), it lacks a carboxylate group. Hence, the protein-ligand interaction of TBT is very different from those seen with other known RXR agonists.

In order to further demonstrate the utility of bioinformatics in foreseeing the capability of environmental pollutants to bind hormone receptors and enzymes, the RXR of a Cnidarian (Actinia equina, the most common species of sea anemone along coastal areas in Europe and the Mediterranean) have been partially cloned (based on degenerate primers, PCR on cDNA, cloning with pGemTeasy system from Promega, and sequencing), and the 3 D structure of Actinia equina was developed based on homology modelling with the Human and Biomphalaria (mollusc) RXR crystal structure, which will be of great utility to subsequently evaluate the capability of TBT, triphenyltin (TPT), methoprene acid, and 9-cis retinoic acid to activate the cnidarian RXR.

Acknowledgments
The authors acknowledge the financial support from the Portuguese Fundação para a Ciência e a Tecnologia (FCT) under the projects PTDC/BIA-BDE/69144/2006 and PTDC/MAR/68106/2006, and to SP (SFRH/BD/47938/2008) and RRF (SFRH/BPD/26769/2006).

References
1 - Antunes A, Ramos MJ. 2007. Gathering Genomics and Proteomics to Unravel Adaptive Evolution. *Evolutionary Bioinformatics* 3:207-209.
2 - Marques A, Antunes A, Fernandes PA, Ramos MJ. 2006. Comparative evolutionary genomics of the HADH2 gene encoding amyloid beta-binding alcohol dehydrogenase/17beta-hydroxysteroid dehydrogenase type 10 (ABAD/HSD10). BMC Genomics 7:202.
3 - Da Fonseca R, Johnson WE, O'Brien SJ, Ramos MJ, Antunes A, 2008. The adaptive evolution of the mammalian mitochondrial genome. BMC Genomics 9: 119.
4 - Marti-Renom MA, Stuart AC, Fiser A, Sanchez R, Melo F, Sali A. (2000) Comparative protein structure modeling of genes and genomes. *Annu. Rev. Biophys Biomol. Struct*. 29, 291-325.

CONCENTRATIONS OF ^{210}PO AND ^{210}PB IN PLANKTON FROM DIFFERENT ZONES OF AEGEAN SEA

Fatih Dursun Arslan [1], Aysun Ugur [1] and Banu Özden [1]*
[1] Ege University, Institute of Nuclear Sciences - banu.ozden@ege.edu.tr

Abstract
Aquatic organisms are capable of concentrating toxic elements within their tissues. In the study, plankton samples have been evaluated for their bioavailability as biomonitors of ^{210}Po and ^{210}Pb in Aegean Sea. The concentrations of ^{210}Po and ^{210}Pb in plankton samples collected in the period of 2004-2005 have been presented. The samples were collected from four distinct regions (Aliaga, Nemrut, Foça and Izmir Bay). The concentrations of ^{210}Po and ^{210}Pb in plankton samples were determined using alpha spectrometry.
Keywords: Plankton, Aegean Sea, Monitoring

^{210}Po and ^{210}Pb are naturally occurring radionuclides within the ^{238}U decay chain, with half-lives of 138.38 days and 22.3 years, respectively. These radionuclides areconsidered as an important source of internal radiation dose to marine organisms [1]. Planktons can accumulate radionuclides very rapidly and retain them for a long time [2]. ^{210}Po level increases with additional material derived from coastal erosion, particulate matter flux from atmosphere and biogenic activity within the aquatic environment. The main source of ^{210}Po in these study regions is the river run-off (Bakirçay and Gediz) from the catchment areas. Wastes which arise from petrochemical and fertilizer industries at Aliaga region effect the contamination in the regions. In our project supported by IAEA, ^{210}Po concentrations in fish species fed with planktons were determined much higher than the average values [3]. Significant amounts of ^{210}Po may be transferred to humans via diet. For these reasons, there is a need for investigation of the accumulation of ^{210}Po and ^{210}Pb by planktonic organisms. All the sampling stations (Aliaga, Nemrut, Foça and Izmir Bay) are located on the western coast of Turkey and indicated in Figure 1.



Fig. 1. The map of sampling location

Plankton species were present in a very wide size range. The cut off sizes used for sample collection in this work (45 µm and 120 µm) were selected to characterize two size classes. Then the samples were weighed and dried in the oven. After standard addition ofpolonium tracer, each sample was completely dissolved with HNO_3, H_2O_2 and HCl. Polonium was spontaneously plated onto a copper disc in 0.5 M HCl in the presence of ascorbic acid to reduce of Fe^{+3} to Fe^{+2} [4,5]. Measurements of ^{210}Po were realized through its 5.30 MeV alpha particle emission, using ^{208}Po (95±1.311 mBq g^{-1}) as the internal tracer. After the first deposition of ^{210}Po, the residual 0.5 M HCl was kept to allow ^{210}Po in-growth from the ^{210}Pb contained in the solution to search supported ^{210}Pb in the samples. The sample was re-plated and the ^{210}Po activity was determined. ^{210}Pb (precursor of ^{210}Po) concentrations were determined from ^{210}Po activities measured after attaining the radioactive equilibrium. The range of ^{210}Po concentrations in plankton samples were observed between 10±2 - 207±23 Bq kg^{-1}(dw). According to obtained results, the concentrations of ^{210}Po in industrial regions are higher than other regions. Petrochemical industry on the coast of Aliaga is an agent for high level of natural radionuclide in the region. The relationship between ^{210}Po concentrations and biomass of plankton was found nonlinear.

References
1 - Ugur, A., Yener, G., and Bassari, A., 2002, Trace metals and ^{210}Po(^{210}Pb) concentrations in mussels (*Mytilus galloprovincialis*) consumed at western Anatolia, Applied Radiation and Isotopes, 57, 565-571.
2 - Parfenov, Yu. D., 1974, Polonium-210 in The Environment and in The Human Organism, At. Energy Rev., 12(1), Institute of Biophysics of The USSR Ministry of Health, Moscow, Union of Soviet Socialist Republics, 75-143.
3 - ^{210}Po and ^{210}Pb In Marine Ecosystem of Aegean Sea Turkish Coast, International Atomic Energy Agency, IAEA Research Contract No: 302-K4.00.24-TUR-12641, B5-TUR-31834.
4 - Flynn W.W., 1968, The Determination of Low Levels of Polonium-210 in Environmental Materials, Anal. Chim. Acta., 43, 221-227.
5 - Ugur, A., 1998, Gökova Körfezi Deniz Sediment Korlarinda Radyoaktif Pb, Po, Ra, Cs, Am ve Pu Izotoplarinin Dagiliminin Incelenmesi, Sediment Hizi ve Tarihleme Çalismalarinda Kullanilmasi, E.Ü. Fen Bil. Nükleer Bil. ABD, Doktora Tezi.

OIL CONTAMINATION IN THE EASTERN MEDITERRANEAN SEA IN 2008

E. Balcioglu [1]*, M. Cardak [1], P. S. Ciftci [1], S. Noureddin [2], A. Saad [3] and M. Fakhri [4]
[1] Istanbul University - ebillur@istanbul.edu.tr
[2] Tishreen University High Institute of Marine Research Lattikia, Syria
[3] Tishreen University Laboratory of Marine Sciences and Aquatic Environment Lattikia, Syria
[4] National Council for Scientific Research, National Centre for Marine Sciences Batroun, Lebanon

Abstract

Oil pollution of the Eastern Mediterranean Sea was investigated at 5 stations from Syria in 2007 and 23 stations from Mediterranean Sea in August 2008. The oil level was determinated using references Iraq crude oil and chrysene. The highest oil pollution in East Mediterranean Sea at Turkish Part, Syrian Part (2007), Lebanon Part, South of Cyprus for crude oil was found as 98,87µg/L, 69,24 µg/L, 20,29 µg/L, 90,96 µg/L, respectively. A comparison of the present results Turkish coast part are more polluted than the examined area. *Keywords:Oil pollution, surface water, Mediterranean Sea.*
Keywords: Eastern Mediterranean, Pah, Surface Waters

Oil pollution in East Mediterranean Sea were investigated earlier [1-7]. Oil pollution level was investigated in Mersin- Iskenderun area, Eastern Part of Mediterranean Sea was examined before and after Iraq petroleum pump [6]. The reference oil used in these studies was crude oil [1,6,7] and chrysene [2-5]. In this study the samples were collected by R/V YUNUS-S during the August in 2008 (Figure 1). The seawater sample was taken in 2,8 L amber glass bottles containing 15 ml dichlormethane (DCM) for preservation. The samples were extracted with DCM and distilled. The residue was dissolved in hexane and analyzed by UVF (Shimadzu RF 5301) at 310/ 360 nm (ex/em). In this study we used references as Iraq crude oil and chrysene (Aldrich). Sampling stations are shown in Fig 1.

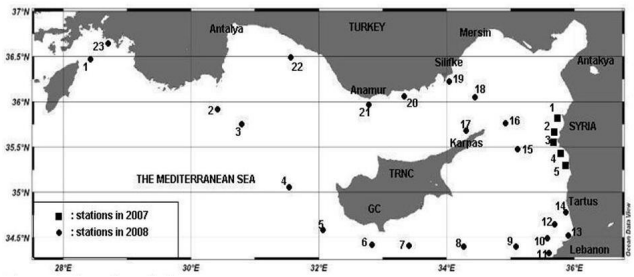


Fig. 1. Sampling stations in Mediterranean Sea

The equation of calibration curve for Iraq crude oil: y= 427,50xC + 2,38 r^2= 0,99, for chrysene: y= 2134,05*C – 3,55 r^2= 0,99.

The oil pollution level examined in sea water are shown in Figure 2. The oil pollution level in Eastern part of Mediterranean were found as 0,4 µg/L (crude oil references) [1], 488,28 µg/L in 1996, 204,6 µg/L in 1997 [6], 2596 µg/L in 1999 for Iraq crude oil equivalent and 455,42 µg/L for chrysene equivalent [7], 25,2 µg/L in 1982 (chrysene equivalent) [2], 1,25 µg/L in 1998 [5]. We found the highest oil pollution level in East Mediterranean Sea as Turkish Part 98,87µg/L for crude oil and 20,05µg/L for chrysene at station 21, at Syrian part 69,24µg/L for crude oil, 14,04µg/L for chrysene at station 5 (2007), at Lebanon part 20,29µg/L for crude oil, 4,09µg/L for chrysene at station 14 and at south of Cyprus part 90,96µg/L for crude oil, 18,39µg/L for chrysene at station 5.

When compared the results of Turkish coast part of East Mediterranean Sea the pollution level increased during the years. This paper presents the first oil level determination in area of East Mediterranean countries included Turkish, Syrian, Lebanon and Cyprus (two parts- North and South).

Acknowledgement: The authors thank to Prof.Dr. K.C.Guven for comments.and Prof.Dr. Bayram Ozturk for the help of cruise organization as East Med.Turk. Project.

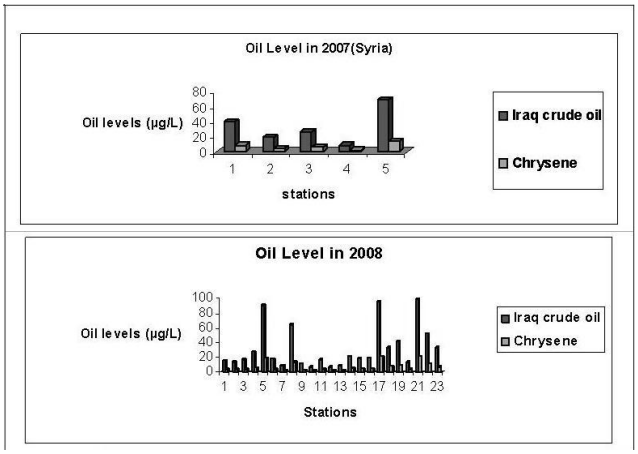


Fig. 2. The oil concentrations found in the samples (µg/L)

References

1 - Ehrhardt, M. and Petrick, G., 1989. Relative concentrations of dissolved /Dispersed Fosil Fuel Residues in Mediterranean surface waters as measured by UV fluorescence. *Mar. Poll. Bull*.20, (11) 560-565.

2 - Saydam, C.,Salihoglu, I., Sakarya, M. And Yilmaz,A., 1984. Dissolved/dispersed petroleum hydrocarbons suspended sediments, plestic pelagic tar and other litter in the North Eastern Mediterranean. VII. Jounees Etud. Pollutions, Lucerne, C.I.E.S.M. 509-519.

3 - Yilmaz A. Saydam, A.C., Basturk, O. and Salihoglu, I., 1991. Transport od Dissolved/dispersed petroleum hydrocarbons in the Northeastern Mediterranean. *Toxicological and Environmental Chemistry* 31-32, 187-197.

4 - Yilmaz, A., Salihoglu, I. and Yayla, M. 1991. Assesment of oil pollution in eastern Mediterranean. International conferance oil spills in the Mediterranean and Black Sea regions 15th- 18th September 1998, Istanbul.

5 - Yilmaz, K., Yilmaz,A., Yemencioglu, S., Sur, M., Salihoglu, I., Karabulut, Z., Telli Karakoç, F., Hatipoglu, E., Gaines, A.F., Philips, O., Hewer, A., 1998 Polynuclear aromatic hydrocarbons (PAHs) in the Eastern Mediterranean Sea. *Marine Poll. Bull*. 36: 922-925.

6 - Güven. K.C., Ünlü, S., Bildaci, I. and Dogan, E. 1998. An Investigation of the oil pollution of the Eastern Mediterranean Coast of Turkey. *Turkish J. Marine Sci.* 4:51-60.

7 - Bildaci, I., Ünlü, S., Güven, K.C. 2000 Oil pollution of Eastern Mediterranean Sea, South of Turkey. *Turkish J. Mar. Sci.* 6: 1-7.

8 - Öztürk, B., Altug, G., Çardak, M., Çiftçi, P.S. 2007., Oil pollution in surface water of the Turkish side of the Aegean and Eastern Mediterranean Seas. *J. Black Sea/Mediterranean Environment*. Vol. 13: 207- 214.

OIL POLLUTION IN THE SURFACE WATER OF THE AEGEAN SEA IN 2007 AND 2008

Esra Billur Balcioglu [1]*, Pelin Saliha Ciftci [1] and Mine Cardak [1]
[1] Istanbul University Fisheries Faculty Ordu cad. No 200 Laleli/Istanbul, Turkey - ebillur@istanbul.edu.tr

Abstract
Oil pollution of the Aegean Sea was investigated at 13 stations in August 2007 and 11 stations in August 2008. The oil level was calculated using references as Iraq crude oil and chrysene. The highest oil pollution was found as 63,09 µg/L at Station 13 in 2007 and 93,58µg/L at station 2 in 2008. A comparison of the present results with data obtained earlier in the same region the oil pollution level increased during the years.
Keywords: Aegean Sea, Surface Waters, Pah

Oil pollution is a major problem of sea water. In this study oil pollution was determined in the surface water of the Aegean Sea at 13 stations in 2007 and 11 stations in 2008. The samples were collected by R/V YUNUS-S during the August in 2007 and August in 2008. Sampling stations are shown in Fig.1. The seawater was taken in 2,8 L amber glass bottles and 15 ml dichlormethane (DCM) was immediately added for preservation. The seawater samples were extracted with DCM. The extract was distilled and the residue was taken with hexane and analyzed by spectrofluorophotometer (Shimadzu RF 5301) at 310/ 360 nm (ex/em). References used are Iraq crude oil was used as reference according to suggestion [1] and chrysene (Aldrich) [2].

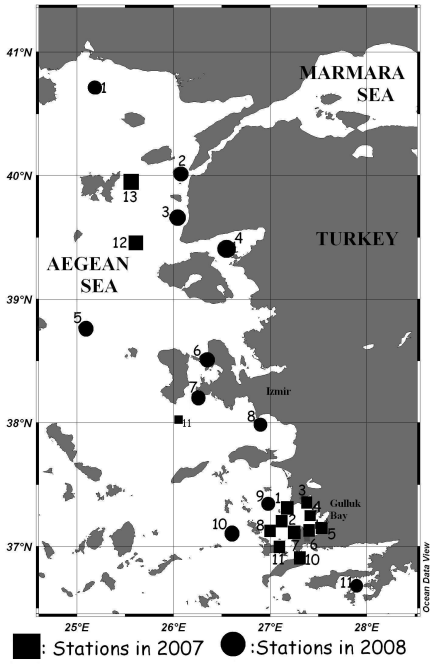


Fig. 1. Sampling station in Aegean Sea

The equation of calibration curve for Iraq crude oil: y= 427,50xC + 2,38 r^2= 0,99 for chrysene: y= 2134,05*C – 3,55 r^2= 0,99. The oil pollution amount in sea water samples are shown in Fig. 2. Oil pollution of the Cretan Sea, Southern Aegean Sea was found at the range of 0.092- 0.317 µg/L [3] in the region of Northern Aegean Sea (Thermaikos Gulf), Greece. Total PAH concentration was ranged from 9,7 to 36,2 ng/L [4]. In Turkish part of Aegean Sea, the oil concentrations were found in coastal and open sea area 0.09- 25.5 µg/L [5], 0.10-2 µg/L and Aliaga and Izmir Bay 10-25 µg/L [6], in Northern Aegean Sea, 0.1-12.5 µg/L [7] and 3.93- 38.28 µg/L in the surface water of the Aegean Sea [8]. As can be seen in Fig.2 the highest oil pollution level was found highest at station 13 as 63,09 µg/L in 2007 and station 2 as 93,58µg/L in 2008. Limit value of oil in sea water is reported as 2.5 µg/L by WHO. According to our findings the pollution level of examined area are higher than limit value given by WHO. When compared all results with earlier findings, the oil pollution level was found are higher than previous studies.

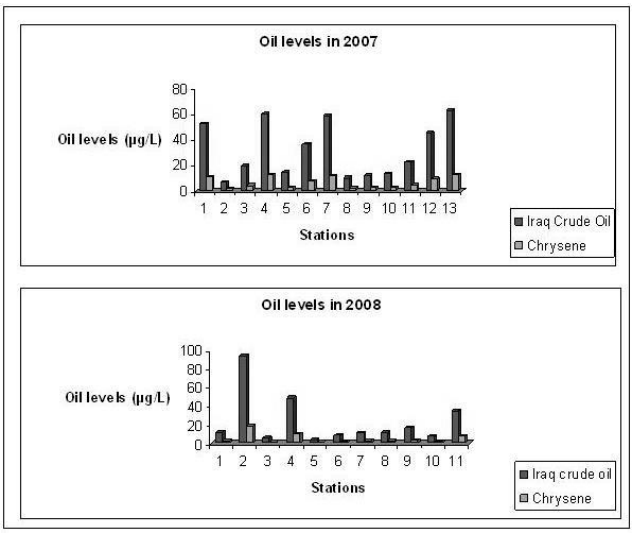


Fig. 2. The oil concentrations found in the samples (µg/L)

Acknowledgement: The authors thank to Prof. Dr. Bayram Ozturk for the help of cruise organization as East Med. Turk. Project.

References
1 - Ehrhardt, M. and Petrick, G. 1989. Relative concentrations of dissolved /Dispersed Fosil Fuel Residues in Mediterranean surface waters as measured by UV fluorescence. Mar. Poll. Bull.20: 560-565.
2 - UNEP, 1986. Baseline studies and monitoring of oil and petroleum hydrocarbons in marine waters (MEDP POL 1). MAP Technical report series, No.1: 81-86. United National Environment Programme, Geneva, Switzerland.
3 - Kornilios, S., Drakopoulos, G.P., Dounas, C. 1998. Pelagic tar, dissolved/ dispersed petroleum hydrocarbons and plastic distribution in the Cretan Sea, Greece. Marine *Mar. Pollut. Bull*. 36:989-993.
4 - Hatzianestis, I. Sklivagou, E, Zervakis, V. Georgopoulos, D. 1998a. Polycyclic aromatic hydrocarbons (PAH) in sea water from the Northern Aegean Sea, Greece. International Symposium on Marine Pollution, Monaco 5-9 October, Extended Synopses. pp. 511-512
5 - Balci, A., 1993. Dissolved and dispersed petroleum hydrocarbons in the Eastern Aegean Sea. *Mar.Pollut.Bull*. 26:222-223.
6 - Kucuksezgin, F., Altay, O., Kontas, A. 1995. Dissolved and dispersed petroleum hydrocarbons and plastic distribution in the Cretan Sea, Greece. *Marine Mar. Pollut. Bull* 36:989-993.
7 - Saydam, C., Yilmaz, A., Basturk, O., Salihoglu, I. 1988. Petroleum hydrocarbons in sea waters, marine organisms and sediments from the Northeastern Mediterranean and Aegean Sea. Rapp Comm. int. Mer. Médit., (31),2
8 - Ozturk, B., Guven, K.C., Nesimigil, F., Cumali, S., Dede, A. 2006. Oil pollution in the surface water of the Aegean Sea. *J. Black Sea/Mediterranean Envrion.*12: 201-212.

DNASE ACTIVITY AS A NEW BIOMARKER FOR MARINE ENVIRONMENTAL CONTAMINATION: FIELD STUDY

Iris Batel [1]*, Maja Fafandel [1], Lorena Peric [1] and Ines Kovacic [1]
[1] Center for Marine Research, Ruder Boškovic institute - bihari@cim.irb.hr

Abstract
In mussels *Mytilus galloprovincialis* collected at different sampling sites and in those injected with organic seawater extracts the DNase activity in the hepatopancreas was higher than in mussels from a maricultured area or control mussels respectively. The enzyme activity in hemocytes decrease, increase or remain constant depending on the specific contamination of the sampling site. The DNase activity, as a novel biomarker, can be useful for the monitoring of marine environmental contamination.
Keywords: Pollution, Adriatic Sea, Bivalves, Enzymes

Introduction
The wide range of mollusks response to pollutants provides grounds for the development of various methods for water toxicity evaluation and development of new biomarkers. The activity of lytic enzymes, such as acid DNase, can provide a new promising model for such studies. The response of acid DNase activity to toxic industrial pollutants in the freshwater snail [1] and in mussels from contaminated areas [2] or in mussels exposed to marine pollutants [3] was recently reported. The aim of this study was to validate the acid DNase activity as a new biomarker for environmental contamination in mussels collected at sampling sites with different pollution histories and in mussels injected with organic extracts of different seawater samples.

Materials and methods
Mussels *Mytilus galloprovincialis* were collected at 6 different locations: shipyard (S2, S6), harbor (S3), river mouth (S4) and urban/industrial waste area (S7). Mussels from a maricultured area served as a reference sample. Another group of mussels was injected with organic extracts of seawater samples collected from different locations along the Croatian Adriatic Coast. The water samples have been collected in a protected area (S1), shipyard (S5), harbor (S9) and urban/industrial waste areas (S7, S8). Mussels injected with DMSO were used as experimental control. After 1h the acid DNase activity was measured in hemocytes and hepatopancreas according to Fafandel et al. [3].

Results and discussion
The specific DNase activity in hemocytes and hepatopancreas of native and injected mussels is presented in Table 1. In mussels collected at sampling sites S2, S3, S4, S6 and S7 the DNase activity in the hepatopancreas was significantly higher than in mussels from a maricultured area. The enzyme activity in hemocytes was significantly higher only at sampling sites S3, S4 and S7. The highest DNase activity in both tissues has been detected in mussels collected at sampling site S7, an area under high influence of urban/industrial wastes. In mussels injected with organic extracts of seawater from various sampling sites (S1, S5, S7 and S9), the DNase activity in the hepatopancreas significantly increased, when compared to the control. The highest enzyme activities (cca. twice as higher as in the control) have been detected in mussels injected with organic extracts of seawater collected in a shipyard ad harbor. The enzyme activity in hemocytes significantly increased only in those mussels injected with organic extracts from the sampling site S9 (harbor) and significantly decreased for those injected with extract from the sampling site S8 (urban/industrial waste area). The suppression of enzyme activity as a specific response of hemocyte acid DNase to organic extract S8 (urban/industrial waste area) could be consistent with its effect on cells of the bivalve immune system [4], including fluctuations in hemocyte numbers [5]. The DNase activity in the hepatopancreas of both native and injected mussels revealed sampling site S7 as the polluted one.

Tab. 1. Specific DNase activity in hemocytes and hepatopancreas of native and injected mussels

Sampling site	HEMOCYTES Specific DNase activity			HEPATOPANCREAS Specific DNase activity		
	ΔF/mg/min*10^{-1}	% of cont.	p < 0.05	ΔF/mg/min*10^{-1}	% of cont.	p < 0.05
Native						
Mariculture	70 ± 22	100	*vs* mari.	11 ± 13	100	*vs* mari.
S2	79 ± 18	112		104 ± 5	914	*
S3	103 ± 12	146	*	91 ± 4	806	*
S4	107 ± 7	152	*	105 ± 2	926	*
S6	86 ± 18	122		105 ± 4	926	*
S7	103 ± 10	146	*	110 ± 6	968	*
Injected						
Control/DMSO	53 ± 14	100	*vs* cont.	30 ± 9	100	*vs* cont.
S1	52 ± 3	97		47 ± 7	155	*
S5	70 ± 8	132		58 ± 3	190	*
S7	52 ± 3	98		48 ± 12	159	*
S8	39 ± 4	74	*	34 ± 8	113	
S9	71 ± 11	134	*	57 ± 15	187	*

Conclusion
The potential use of the acid DNase response in hepatopancreas and hemocytes of mussels *Mytilus galloprovincialis* for the determination of mixed marine environmental contamination is confirmed. The DNase activity as a biomarker could be applied for both native and injected mussels. The latter might be used when the native ones are not available. At the same time, the DNase activity could be included during the determination of various enzymes activities in protein microarrays in the monitoring of integrative biological effects of contaminants.

References
1 - Popov, A.P., Konichev, A.S., Tsvetkov, I.L., 2003, Effect of toxic industrial pollutants on the activity and isoforms of acid DNase in the fresh-water snail *Viviparus viviparus* L., *Appl. Biochem. Microbiol.* 39, 454-458.
2 - Menzorova, N.I., Rasskazov, V.A., 2007, Application of different test systems and biochemical indicators for environmental monitoring in the Troitsa Bay, Sea of Japan, *Russ. Jur. Mar. Biol.* 33, 118-124.
3 - Fafandel, M., Bihari, N., Peric, L., Cenov, A., 2008. Effect of marine pollutants on the acid DNase activity in the hemocytes and digestive gland of the mussel *Mytilus galloprovincialis, Aquat. Toxicol.* 86, 508-513.
4 - Anderson, R., Mora, L., Thomson, S., 1994. Modulation of oyster (*Crassostrea virginica*) hemocyte function by copper as measured by luminal-enhanced chemiluminescence, *Comp. Biochem. Physiol. C* 108, 215-220.
5 - Sunila, I., 1984, Copper and cadmium-induced histological changes in the mantle of *Mytilus edulis* L. (bivalvia), *Limnologica* 15, 523-527.

THE LIMPET: *PATELLA CAERULEA* AS BIOMONITORS OF THE HEAVY METAL LEVELS IN TUNISIAN NORTH COASTS, MEDITERRANEAN SEA

Hela Belkhodja [1]*, Hechmi Missaoui [2] and Mohamed Salah Romdhane [3]
[1] Institut Supérieur de Pêche et d'Aquaculture de Bizerte - hela.belkhodja@yahoo.fr
[2] Direction Générale de la pêche et de l'Aquaculture de Tunis - Tunisie
[3] Institut National Agronomique de Tunis, 43 av. Charles Nicolle, 1082, Tunis - Tunisie

Abstract
This work contributed to the study of accumulation of eight metals such as Cu, Cd, Cr, Ni, Mn, Al, Fe and Pb in the Gastropod *Patella caerulea* collected at three stations along the Tunisian North coasts. Result showed that the mean values of the heavy metals in soft tissues were relatively higher at CB station, considered as the worst affected region among the studied areas. The order of metal accumulation in the animal was: Fe >> Al >> Mn - Cu > Ni – Pb > Cr > Cd, where, Mn, Cu, Ni and Pb were changeable in their order at different stations.
Keywords: Gastropods, Metals

P. caerulea is selected as a cosmopolite bioindicator for the biomonitoring of metal traces in Mediterranean. Between 30 and 40 specimens were handpicked in the tidal zone from three sites (Bizerta Channel, La Goulette and Sidi Rais). Organisms were depurate and soft tissue was dried, Pulverized and mineralized. Heavy metals analyses were performed in the limpet samples according to the method described by AOAC (2000) [1]. Comparison between stations for the concentration for all metals revealed that The highest mean values of the heavy metals in soft tissues of *Patella caerulea* were found: at CB station, for Cd (1.50) µg g^{-1}, Cr (2.78) µg g^{-1} and Fe (2.59) mg g^{-1}. We also notice at the same station relatively high mean values for Ni, Al and Pb (3.43, 402.16 and 3.51 µg g^{-1}), respectively (Table 1).

Tab. 1. Mean concentrations of metals in soft tissue of *P. caerulea* collected from the North coasts of Tunisia since summer 2006 until the spring 2007[a] $mg.g^{-1}$

	Metals							
	Fe[a]	**Mn**	**Cu**	**Cd**	**Cr**	**Ni**	**Al**	**Pb**
CB	2.59	5.14	5.59	1.50	2.78	3.43	402.16	3.51
LG	1.86	10.76	9.29	0.78	0.99	3	351.87	3.61
SR	2.39	9.52	5.87	0.43	2.04	4.14	702.37	2.73

This contamination could be attributed to wastes discharged from Bizerta city and the ships awaiting transit through Bizerta Channel. This zone also receives waste effluents from different industrial unities. Mean iron concentration was much greater than that of the other metals in each station. Similar results reported that Iron is the predominant metal in marine molluscs from the Mediterranean Sea ([2], [3], [4]). Cd concentrations were minimal. The levels found in this work are lower than those registered in limpets from some other parts of the Mediterranean coasts ([5], [6]). Lead levels in *P. caerulea* were in the same order of magnitude in 3 stations. In this present study, Lead concentrations in limpets were higher than those mentioned by [7] in Gulf of Suez and ([5], [8], [6]) in Italy. However, toxic metal concentrations (Cd, Pb) remain lower than the thresholds recommended by the World Health Organisation (WHO). We notice that the order of metal accumulation in the animal at different stations was: Fe >> Al >> Mn - Cu > Ni – Pb > Cr > Cd, where, Mn, Cu, Ni and Pb were changeable in their order at different stations. The observed variation in metal levels in *P. caerulea* at different stations may be related to the environmental conditions of the area and to the physiological conditions of the animal regarding the metal.

References
1 - Association of Official Analytical Chemists., 2000. AOAC official method 968.08. Minerals in Animal Feed and Pet Food. In *Official Methods of Analysis* 17th ed. (ed W. Horwitz) vol. I, Washington DC: AOAC International, pp 40.
2 - Nicolaidou A. and Nott J. A., 1998. Metal in sediment, seagrass and gastropods near a nickel smelter in Greece: possible interactions.*Mar. Poll. Bull.*, 36 (5): 360 – 365.
3 - Miguel C. S., Machado L. M., Bebianno M. J.,1999. Variacoes de Cd, Cu e Zn emmexilho˜es Mytilus galloprovincialis e lapas P. aspera ao longo da costa Algarvia (Sul de Portugal). Ecotoxicology Environment Rest, 2(1): 1–6.
4 - Cravo A., Bebianno M. J. and Foster P., 2004. Partioning of trace metals between soft tissues and shells of *Patella aspera*. *Environmental International*, 30 (1): 87 – 98.
5 - Cubadda F., Conti M. E., Campanella L., 2001. Size-dependent concentrations of trace metals in four mediterranean gastropods. *Chemosphere* 45: 561–569.
6 - Conti M. E., Cecchetti G., 2003. A biomonitoring study: trace metals in algea and molluscs from Tyrrhenian coastal areas. *Mar. Env. Res.* 93: 99–112.
7 - Hamed M. A., 1996. Determination of some micro-elements in aquatic ecosystem and their relation to the efficiency of aquatic life. Thesis, Mansoura University.134.
8 - Campanella L., Conti M. E., Cubadda F., Sucapane C., 2001. Trace metals in seegrass, algae and molluscs from an uncontaminated area in the Mediterranean. *Env. Poll.*, 111: 117–126.

DISTRIBUTION OF MERCURY IN TISSUES AND ORGANS OF TWO CETACEAN SPECIES (*STENELLA COREULEOALBA* AND *TURSIOPS TRUNCATUS)* STRANDED ALONG THE ITALIAN COASTS

A. Bellante [1], M. Sprovieri [2], G. Buscaino [1]*, D. Salvagio Manta [2], G. Buffa [1], V. Di Stefano [1], A. Bonanno [1], F. Filiciotto [1], M. Barra [2], P. Labruzzo [1], B. Patti [1], C. Giacoma [3] and S. Mazzola [1]

[1] Institute for Coastal Marine Environment (CNR), Torretta Granitola, Italy - giusy.buscaino@irma.pa.cnr.it

[2] Institute for Coastal Marine Environment (CNR), Naples, Italy

[3] Animal and Human Biology Department, University of Turin, Turin, Italy

Abstract

Mercury concentrations were determined in tissues and organs of two cetacean species (*Stenella coreuleoalba* and *Tursiops truncatus)* stranded along the Italian coasts between 2000 and 2009. According to previous authors, mercury accumulates preferentially in liver and shows a positive correlation with length in both analysed species. Mercury concentrations found in this study are generally higher than those found by previous authors in tissues of dolphins from Atlantic areas. Significant differences were also found for Hg contents in different marine areas within the Mediterranean basin suggesting the existence of different and separated populations of *S. coreuleoalba* and *T. truncatus*.

Keywords: Cetacea, Mercury

Large amounts of organic and inorganic chemicals enter estuarine and coastal marine environments from natural and anthropogenic sources. Several metals, such as mercury, are considered highly toxic [1], and, at least in dolphins, are accumulated throughout the entire life of an individual. The main aims of this research is at attempting to: (1) verify, on the basis of a new and larger dataset, previously reported mercury distribution patterns in cetaceans; (2) verify differences on mercury concentrations between sampling areas within the Mediterranean basin to assess the importance of cetacean as indicator of marine pollution. Samples of muscle, liver, lung, kidney and heart were collected from specimens of *S. coeruleoalba* (n=12) and *T. truncatus* (n=12) that were foundstranded along Italian coasts during the period 2000-2009. Metal concentrations were measured by ICP-AES Varian Vista MPX. Liver shows the highest concentrations of Hg in all analysed species. Positive correlations emerges between Hg concentrations and length in all analysed tissues indicating that bioaccumulation occurred over time. Mercury concentrations found in this study seem to be higher than those found by previous authors in tissues of dolphins from Atlantic areas. Higher Hg concentrations were found in liver of specimens from the French coast [2] and Adriatic sea [3]. Dolphins seem to exhibit lower Hg concentrations in Ligurian sea [4] and Sicily channel (this study). These differences may reflect the existence of different and separated populations of *S.coreuleoalba* and *T. truncatus* in Mediterranean basin with different feeding habitats exposed to different anthropogenic activities.

References

1 - Neff J.M. (2002). Bioaccumulation in Marine Organisms: Effect of Contaminants from Oil Well Produced Water; Elsevier, 452 pp., ISBN0-080-43716-8.

2 - Andre J.M., Boudou A., Ribeyre F., Bernhard M., 1991b. Comparative study of mercury accumulation in dolphins (*Stenella coeruleoalba*) from French Atlantic and Mediterranean coasts. *Sci. Total Environ.* 104:191–209.

3 - Cardellicchio N., Decataldo A., Di Leo A., Misino A., 2002. Accumulation and tissue distribution of mercury and selenium in striped dolphins (*Stenella coeruleoalba*) from the Mediterranean Sea (southern Italy). *Environmental Pollution.* 116: 265–271.

4 - Capelli R., Drava G., De Pellegrini R., Minganti V., Poggi R., 2000. Study of trace elements in organs and tissues of striped dolphins (*Stenella coeruleoalba*) found dead along the Ligurian coasts (Italy). *Adv. Environ.Res*. 4: 31–43.

COMPARATIVE STUDY OF ORGANIC MATTER WITHIN PHOSPHATIC GRAINS AND THEIR EXOGANGUE (RAS-DRAÂ DEPOSIT-TUNISIA). RELEVANCE TO PHOSPHATIC PELLETS GENESIS

Aida Ben Hassen [1]*, Jean Trichet [2] and Jean-Robert Disnar [2]

[1] Laboratoire de Géoénergie, Technopole Borj Cédria - aida.benhassen@crten.rnrt.tn

[2] Institut des Sciences de la Terre d'Orléans, Université d'Orléans/CNRS/Université François Rabelais - Tours (UMR 6113), Campus Géosciences, 1A rue de la Férollerie, 45071 Orléans Cedex 2, France

Abstract

The geochemical characterization of organic matter (OM) within phosphatic pellets (100-500 µm) and their surrounding matrices (<50 µm), collected from ypresian phosphorites (Ras-Draâ mine, Tunisia) indicates that : (1) Total Organic Carbon (TOC) content is more important in matrices than in pellets from the same layer; (2) A Marine planktonic origin of OM (Type II domain) contained in both fractions; (3) A diagenetic evolution of OM up to, and not beyond, the stage of humic compounds in both fractions; and (4) A higher abundance of extractable humic compounds in pellets (~70% TOC) and a lower extraction yield in matrices (~18% TOC). Such differences in geochemical properties between pellets and matrices are indicators of an allochtonous origin (fecal origin) of these grains within their embedded sediments.

Keywords: Organic Matter, Fecal Pellets, Geochemistry

Introduction

Several investigations of Tunisian phosphatic deposits have already showed that phosphatic components are essentially concentrated in phosphatic grains, called "pellets", varied in size (mainly 100 to 500 µm). These grains are surrounded by a sedimentary matrix, also named exogangue. The origin of phosphatic pellets has long been an intriguing problem, especially with regard to the source of the accumulated phosphorus. Two convergent hypothesis for the origin of pellets were proposed: either pellets were diagenetic, authigenic, bodies formed within and from the matrix and still containing chemical elements inherited from the matrix, or the pellets were allochtonous bodies (for example faecal pellets), formed outside the matrix. The present work aimed to carry compared studies of their geochemical properties and to draw some relevant conclusions on the genesis of the Ras-Draâ ore pellets.

Material and methods

The studied samples were collected from the Ras-Draâ deposit (southern Tunisia), witch is a natural continuity of the great Gafsa-Metlaoui phosphatic basin (Fig. 1). The phosphatic grains ("pellets", 100 to 500 µm in mean diameter) were separated from their surrounding sediments ("matrix", < 50 µm) by granulometric fractionation under water. The comparative study of both fractions was performed by: global chemical analyses (CNS elemental analysis), Rock-Eval (RE) pyrolysis and humic substances (HS) extraction and fractionation according to the IHSS (International Humic Substances Society) procedure.

Results and discussion

Elemental analysis: The Total Carbon (C_T) content in the phosphatic pellets is ~ 2.31% compared to ~ 3.52 % in the matrices. Total Nitrogen and Sulphur contents (N_T and S_T) are also significant and fairly homogeneous in the two respective fractions (N_T pellets ~ 0.03 %, N_T matrices ~ 0.07 %, S_T pellets ~ 0.11 %, S_T matrices ~ 0.16 %).

Rock-Eval pyrolysis: The TOC content, given by the RE pyrolysis, varies between 0.30 % and 1.62 % in phosphatic pellets and between 1.22 % and 4.05 % in their adjacent matrices. The geochemical characterization of OM contained in the two fractions by RE pyrolysis concludes, on one hand, to the planktonic origin of the OM (Type II domain), in both fractions, and, on the other hand, to a low degree of maturity of the pelletal and matricial OM (RE Tmax < 430 °C).

Humic substances extraction: The HS yields from the pelletal and matricial OM shows a high content of humic compounds isolated from pellets (humic carbon up to 75% of TOC) and a lower one in adjacent sediments (humic carbon less than 21% of TOC), along with the higher content of HU (low mature kerogen) in surrounding sediments and the lowest in the pellets. Such high amounts of humic compounds are similar to those isolated from Gafsa-Métlaoui phosphorites (Belayouni and Trichet 1983).

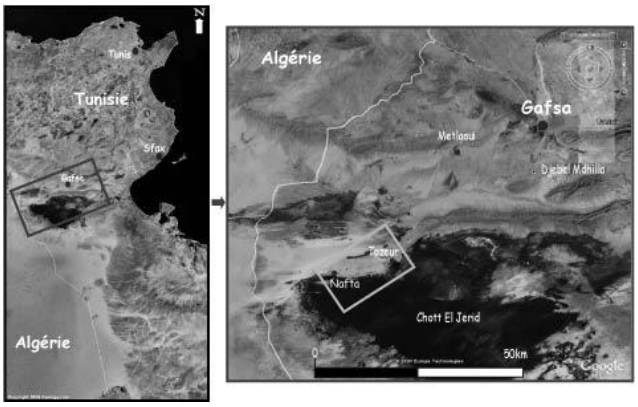


Fig. 1. Location map of the Ras-Draâ phosphate ore deposit in the Gafsa-Métlaoui basin, Tunisia (source: www.earth.google. fr)

Conclusion

Several organic geochemical data from the phosphatic grains and their surrounding matrix reveal great differences between the both fractions. Such differences excludes that the pellets formed authigenetically within and from their embedded sediments. The reasons of these different properties must been sought in the origin and the diagenetic history of the grains and of the matrix. Instead, as recently hypothetized (Ben Hassen 2007), these phosphatic pellets must have an allochtonous source, namely a biological origin since they are, very certainly, fish feces.

References

1 - Belayouni H. and Trichet J., 1983. Preliminary data on the origin and diagenesis of the organic matter in the phosphate basin of Gafsa (Tunisia), In BjØroy et al., John Wiley and Sons, Eds., Advances in Organic Geochemistry 1983. pp. 328-335.

2 - Ben Hassen A., 2007. Données nouvelles sur la matière organique associée aux séries du bassin phosphaté du sud-tunisien (Gisement de Ras-Draâ) et sur la phosphatogenèse. Thèse de Doctorat, Université d'Orléans. France.

3 - Sassi S., 1974. La sédimentation phosphatée au Paléocène dans le sud et le centre-ouest de la Tunisie. Thèse de Doctorat es-Sciences, Université de Paris-Orsay, France.

ORGANOTINS ACCUMULATION IN THE NORTH-WESTERN ADRIATIC SEA FOOD WEB INVESTIGATED BY STABLE ISOTOPES RATIOS (13C/12C;15N/14N)

M. Bernardello [1], M. Formalewicz [1], C. Gion [1], A. Feller [1], F. Rampazzo [1], I. Celic [1], S. Raicevich [1]*, D. Berto [1], M. Giani [2] and O. Giovanardi [1]

[1] ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale - sasa.raicevich@isprambiente.it

[2] OGS - Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Dipartimento di Oceanografia Biologica, via August Piccard, 54, 34151 Trieste, Italy

Abstract

The accumulation of tributyltin (TBT), dibutyltin (DBT) and monobutyltin (MBT) in the North-western Adriatic Sea food web was investigated by evaluating contamination and stable isotopes ratios (13C/12C; 15N/14N) in biota and sediments. Results showed higher contamination in estuarine areas as well as their accumulation with increasing trophic levels.

Keywords: Food Webs, Adriatic Sea, Pollution, Bio-Accumulation

TBT has been directly introduced in the marine environment due to its extensive use as biocide in antifouling paints [1]. Several studies reported various toxic effects and a widespread bioaccumulation of butyltins (BTs) in different species of marine and coastal ecosystems [2]. Accumulation of tributyl and triphenyltin compounds in marine food webs of coastal waters was reported, however it is still unclear whether biomagnification through food-webs occurs [3]. Recent studies have rapidly advanced the understanding of biomagnification profiles of environmental pollutants using 13C/12C and 15N/14N but their application to BTs is still limited [4]. Sediments and biota samples (zooplankton, bivalves, crustaceans, cephalopods, bony fish; total number of samples = 41) were collected in autumn 2008 in an estuarine-riverine and a coastal-marine area of the North-western Adriatic Sea. Analyses were performed in bivalves on whole soft tissues while in crustaceans, cephalopods and bony fish on muscle pooled from several individuals. Stable isotopes (13C/12C; 15N/14N) were analysed by a CHN analyzer coupled with Isotope Ratio Mass Spectrometer. BTs were analysed on freeze-dried samples by high resolution gaschromatography coupled with ion trap mass spectrometer (HRGC-MS^2) after ultrasonic solvent extraction, Grignard methylation and clean-up. values ranged between -28.22 ‰ and -16.56 ‰ with lower values in biota and sediments from the riverine-estuarine area compared to the coastal-marine ones. 15N/14N ranged from 4.74 ‰ to 13.88 ‰, with higher ratios recorded for bony fishes (both in the riverine-estuarine and coastal-marine area) compared to cephalopods, crustaceans, bivalvia and zooplankton. ΣBT (TBT+DBT+MBT) ranges in sediments and in biota were <10 – 83 and <10 –114 ng Sn g^{-1} dw (dry weight), respectively. TBT generally accounted for the major fraction (average ~40%) of ΣBT. Higher levels of contamination were observed in the riverine-estuarine samples. The significant negative correlation found between TBT, DBT, ΣBT and 13C/12C (Spearman rank correlation; R ranged between -0.38 and -0.46 $p<0.05$) in the higher taxonomic groups (crustaceans, cephalopods and bony fish) could reflect higher BTs contamination in the riverine-estuarine area. Bioaccumulation of BTs increased with the trophic levels as highlighted by the significant positive correlation between TBT, DBT, ΣBT and 15N/14N (Spearman rank correlation; R ranged between 0.40 and 0.43; $p<0.05$). Further work is in progress in order to confirm the biomagnification hypothesis with a greater number of samples and *taxa* allowing a comparison with the few studies based on a similar approach [4], [5].

References

1 - Hoch M., 2001. Organotin compounds in the environment-an overview. *Appl. Geochem*., 16: 719-743.

2 - Fent K., 1996. Ecotoxicology of organotin compounds. *Crit. Rev. Toxicol*., 26 (1): 1-117.

3 - Strand J. and Jacobsen J.A., 2005. Accumulation and trophic transfer of organotins in a marine food web from the Danish coastal waters. *Sci. Total Environ*., 350: 72– 85

4 - Murai R., Sugimoto A., Tanabe S. and Takeuchi I., 2008. Biomagnification profiles of tributyltin (TBT) and triphenyltin (TPT) in Japanese coastal food webs elucidated by stable nitrogen isotopes ratios. *Chemosphere*, 73: 1749-1756.

5 - Hu J., Zhen H., Wan Y., Gao J., An W., An L., Jin F. and Jin X., 2006. Trophic magnification of Triphenyltin in a marine food web of Nohai Bay, North China. Comparison to Tributyltin. *Environ. Sci. Technol.*, 2006: 40 (10): 3142-3147.

ANALYTICAL DETERMINATION OF NONYLPHENOLS AND OCTYLPHENOLS IN SURFACE WATER SAMPLES

M. Bernardello [1]*, M. Formalewicz [1], C. Gion [1], A. Feller [1] and C. Maggi [2]
[1] ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale - Loc. Brondolo, 30015 Chioggia - marco.bernardello@isprambiente.it
[2] ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale - via di Casalotti 300, 00166 Roma

Abstract
Decision N. 2455/2001/EC sets out the first list of 33 substances or groups of substances that have been prioritised for action at European Community level. Nonyl- and octylphenols are included in this list of priority and hazardous substances due to the risk to, or via, the aquatic environment, in accordance with the Article 16 of European Water Framewok Directive 2000/60/EC (WFD) [1]. A method for the selective determination of 4-tert-octylphenol, 4-nonylphenol and 4-n-nonylphenol in surface water samples was developed and validated, based on solvent extraction and HRGC-ITMS (high resolution gaschromatography coupled with ion-trap mass spectrometry). Assessment of method performance gave good results in terms of accuracy, precision, selectivity and sensitivity.
Keywords: Chemical Analysis, Pollution, Monitoring

Introduction
The European Union (EU) Water Framework Directive 2000/60/EC (WFD) [1] sets up environmental objectives to achieve ''good chemical status'' for all European water bodies by 2015. "Nonylphenols" and "octylphenols" are listed as priority hazardous substances in Decision n. 2455/2001/CE [2]. The Directive 2008/105/EC [3] lays down environmental quality standards (EQS) for priority substances and certain other pollutants amending the WFD. EU Member States need to develop and to implement a quality-assurance/quality control (QA/QC) system to ensure that all monitoring results meet the levels of accuracy fixed by Directive 2009/90/EC of 31.07.2009. Nonylphenols and octylphenols are two groups of substances with general formulas $HO\text{-}C_6H_4\text{-}C_9H_{19}$ and $HO\text{-}C_6H_4\text{-}C_8H_{17}$, respectively. Alkylphenolic compounds in the aquatic environment originate primarily from the degradation of the industrially produced mixtures of alkylphenol polyethoxylates, resulting in complex mixtures of branched isomers which differs on the basis of branching and position of the alkyl chain with respect to the phenolic hydroxyl group [4]. The denomination of alkylphenols used in legislation, as well as in scientific literature, has proved sometimes ambiguous for identifying mixtures and single isomers. In this work a method was devised for analysing 4-*tert*-octylphenol (4-t-OP; 1,1,3,3,-tetramethyl-4-buthylphenol, single compound, CAS# 140-66-9), 4-*n*-nonylphenol (4-*n*-NP; linear-chain isomer, single compound, CAS# 104-40-5) and 4-nonylphenol (4-NP; mixture of para-substituted isomers, CAS# 84852-15-3 and CAS# 25154-52-3) in surface water samples. 4-NP is usually quantified in environmental samples by using technical mixtures of isomers, which can be resolved by HRGC-LRMS only at a group level [4,5].

Materials and methods
The method is based on extraction with toluene followed by clean-up on a silica-gel column. Qualitative and quantitative determination was carried out by means of HRGC-ITMS. ^{13}C labelled 4-n-NP was used as internal standard and added to the sample before extraction. In order to determine precision and accuracy, the performance of the method was assessed by the analysis of spiked water samples, as no certified reference materials were available.

Results and discussion
The identification of analytes was performed on the basis of chromatographic retention time and by comparing Full Scan mass spectra of the analyte in the sample and in the calibration standards, after calculation of area ratios of characteristic ions as confirmation. 4-NP mixture eluted as a group of partially resolved peaks (5 to 11 depending on the selected ion) leading to distinctive chromatographic patterns. The quantitative determination was performed by means of the internal standard method. Calibration curves were calculated from the ratios of chromatographic areas of the analyte and the internal standard as a function of concentrations. 4-NP were quantified by the sum of areas of the identified peaks. Average recoveries of the analytes in spiked samples ranged between 89 % and 108 %. Good sensitivity was achieved. Limits of quantification were respectively 10 ng L^{-1} for 4-t-OP and 4-n-NP and 100 ng L^{-1} for 4-NP. The developed method has provided reliable analytical performance coupled with a relatively simple sample treatment.

References
1 - Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. OJ L 327, 22.12.2000, p. 1.
2 - Decision n. 2455/2001/EC of the European Parliament and of the Council of 20.11.2001 establishing the list of priority substances in the field of water policy and amending Directive 2000/60/EC. OJ L 331, 15.12.2001, p.1.
3 - Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council. OJ L 348, 24.12.2008, p. 84.
4 - Fries E. and Püttmann W., 2003. Occurrence and behaviour of 4-nonylphenol in river water of Germany. *J. Environ. Monit.* 5, 598–603.
5 - Espejo R., Valter K., Simona M., Janin Y. and Arrizabalaga P., 2002. Determination of nineteen 4-alkylphenol endocrine disrupters in Geneva municipal sewage wastewater. *J. Chromatogr. A* 976, 335–343.

HEAVY METAL CONTAMINATION IN SEDIMENTS OF THE SHALLOW WATER AREAS SURROUNDING THE CITY OF VENICE (ITALY)

M. Botter [1]*, D. Cassin [1], M. Scattolin [2], R. Pini [3] and R. Zonta [1]
[1] National Research Council – Institute of Marine Sciences (CNR-ISMAR) - margherita.botter@ve.ismar.cnr.it
[2] Venice Municipality – Via Scarsellini 36/2, Marghera 30175 Venice (Italy)
[3] CNR-ISE, via Moruzzi 1, 56124 Pisa (Italy)

Abstract
Part of the pollutant load generated by the Venice urban system can be transferred to the sediment of the shallow water areas surrounding the city. These areas were studied in order to assess metals level and distribution in the sediment, and to highlight possible contributions due to the city. A moderate pollution was found in the surface sediments (0-30 cm), with concentration of the main contaminants ranging between 6% (Cd) and 29% (Hg) of the mean value measured in the canal network. The comparison of metal concentrations with SQGs revealed a low ecotoxicological risk for the surveyed areas, excepting for Hg, which values exceed the ERM guideline (0,71 mg/kg d.w.) in 75% of samples. Concentration trends along the vertical profile pointed out a diminution of both metal contamination and the finer particle content with time.
Keywords: Sediments, Metals

The City of Venice, located in the middle of the lagoon, has a population of about 60000 inhabitants and an average additional daily presence of about 75000 units (tourists and commuters). Its 40 km long canal network receives inputs of particulate matter and pollutants from the urban sewage system and point and non-point sources, such as atmospheric deposition and urban runoff, building erosion and corrosion of metal structures, boat traffic [1]. Even though the canal network has a high capability in retaining particles and associated contaminants, a fraction of the total load is transferred to the lagoon [2] by tidal currents. The export is enhanced by particle resuspension due to the boat traffic. Contaminants can therefore accumulate in the sediment of the shallow water areas surrounding the city, which are characterized by a low hydrodynamics. Aim of this study was the assessment of the pollution level in the sediment of these areas, also to evidence possible contributions due to the city. Thirty centimetres-long cores where collected in 2003 and 2004 from 69 sampling sites; cores were sliced into 10 cm layers and analyzed for grain-size distribution and metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn) concentration. A further sediment characterization survey was made in 2008, collecting 26 new cores. Surface sediment samples are mainly constituted of silt (mean content = 55.1 %, σ = 14.7 %), but display a high variability in grain-size characteristics. A positive gradient of the mud (d<63 mm) content is observed towards the West. Table 1 shows metal mean concentration in each analysed sediment layer; for comparison, mean values determined in the whole canal network are reported [1]. The table also shows the percentage distribution of concentration data with respect to the three concentration ranges which are discriminated by the NOAA Sediment Quality Guidelines (SQGs): effect range-low (ERL) and effect range-median (ERM). Concerning the spatial distribution, Cd (0,1-6,9 mg/kg d.w.), Cu (5-144), Pb (4-126), and Zn (27-327) show the greater variability among the shallow water areas. On the average, these metals have a concentration of about 10% with respect to values measured in the canal network. Arsenic, Cr, and Ni concentrations are relatively low in the investigated areas, as well as in the canal system. An effective fingerprint due to the city is observed for Hg (Figure 1). Its concentration is always higher than the ERL value (0,15 mg/kg d.w.), and higher than the ERM value (0,71 mg/kg d.w.) in 75 % of samples. As the other metal concentrations never exceed the ERM, the ecotoxicological risk of the sediment is enhanced by mercury. Concerning the surface layer (0-10 cm), a comparison between data from sediments collected in 2003-04 and in 2008 was made. Lower values characterize almost all samples analysed in 2008, pointing out a diminution of concentrations with time. This is accompanied by a greater presence of finer particles with depth, as resulting by the examination of grain-size along the vertical profile.

Tab. 1. Metal mean concentrations (mg/kg, dry weight) in the investigated areas and in the Venice canal network. In the last three rows, the percentage distribution of concentration data with respect to the NOAA SQGs is reported.

		As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
mean	layer 0-10 cm	6,9	0,71	10	28	1,06	7	23	99
	layer 10-20 cm	8,0	0,57	13	29	1,10	8	27	90
	layer 20-30 cm	8,2	0,40	15	28	1,09	9	29	74
	Venice canals network	16,6	6,60	31	245	3,70	36	222	889
percentage	< ERL	59	91	100	80	0	100	96	88
	ERL - ERM	41	9	0	20	25	0	4	12
	> ERM	0	0	0	0	75	0	0	0

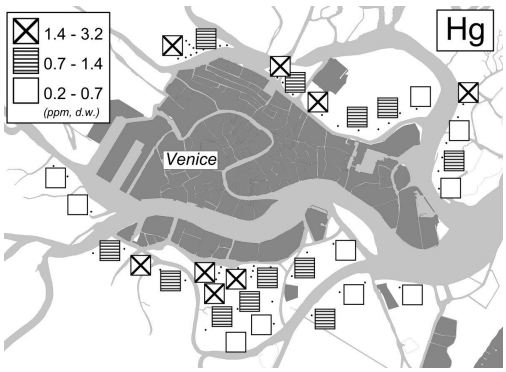


Fig. 1. Mercury concentration distribution in the surface sediment layer (0-10 cm) of the shallow water areas surrounding Venice

References
1 - Zonta R., Zaggia L., Collavini F., Costa F., Scattolin M., 2005. Sediment contamination assessment of the Venice canal network (Italy). In: Fletcher C.A. and Spencer T. (eds.), Flooding and Environmental Challenges for Venice and its Lagoon: State of Knowledge. Cambridge University Press (UK), pp 603–615.

2 - Zonta R., Zuliani A., Coraci E., D'Este C., Pesce A., 2006. Fluxes of particulate, metals and nutrients in a test canal of Venice (Italy) Proc. 41st International Conference ECSA, Venice, Italy, 15 -20 October, p 106.

BIOMARKERS AS TRACERS OF ORGANIC CARBON FLUXES IN THE SW BLACK SEA: A 1-YR SEDIMENT TRAP EXPERIMENT (SESAME PROJECT)

I. Bouloubassi [1]*, A. Gogou [2], E. Plakidi [2], A. Lorre [1], G. Kambouri [2], I. Stavrakaki [2] and S. Stavrakakis [2]
[1] LOCEAN, CNRS/Université P. et M. Curie, Paris, France - ioanna.bouloubassi@upmc.fr
[2] HCMR, Institute of Oceanography, Anavyssos, Greece

Abstract

Source-specific lipid biomarkers have been investigated in settling particles recovered from a 1-year sediment trap experiment in the SW Black Sea in 2007-2008. Biomarker amounts and fluxes unravel major marine organic carbon sources. Their temporal patterns mainly reflect primary production variability both quantitative and qualitative (phytoplankton species succession). Comparisons with bulk parameters allow characterising the settling material and assessing the main processes controlling carbon export.
Keywords: Time Series, Particle Flux, Carbon, Black Sea

Gaining insights on carbon cycling and on carbon export is one of the tasks of the European project SESAME. To this purpose, three mooring lines were deployed for 1 year in the Western and Eastern Mediterranean and in the Black sea, each equipped with two sediment traps set at mid- and deep waters. Besides bulk parameters (mass flux, organic carbon, carbonates, opal) we have conducted a study on molecular lipid biomarkers in settling particles aimed at assessing the sources of the organic carbon and at providing clues on major processes that control carbon export/cycling. Here we present data from the Black Sea deployment (43°01N-29°28E, 2000m water depth) spanning the period from October 07 to December 08, with a 15-days resolution. The investigated source-specific biomarkers are *n*-alkanes, highly branched isoprenoids (HBI), sterols, alkenones and diols. They have been analysed by gas chromatography and gas chromatography-mass spectrometry following published procedures [1].

Long chain *n*-alkanes tracing terrestrial sources generally show medium-range concentrations typifying a system that does not receive major terrestrial inputs. Nevertheless, their temporal variations reveal an elevated contribution of terrestrial organic carbon in April-May 08, a period of enhanced discharges of the Danube River. Yet, marine organic sources, deriving from primary production, are predominant in the study area. Specific sterols (brassicasterol, 24-methylene-cholesterol) and HBI trace diatom inputs and show extremely high concentrations and fluxes, typical of highly productive marine settings. Diatoms appear to be major sources of the exported organic carbon in late fall 08, where HBI suggest the presence of *Rhizosolenia* diatoms. Secondary maxima are observed in late spring 08, and fall 08 (Figure 1).

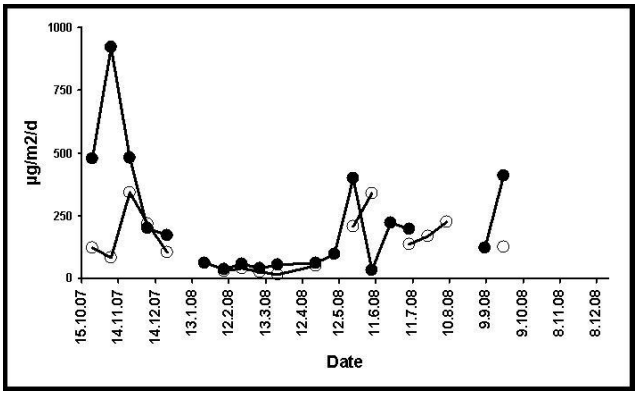


Fig. 1. Fluxes of brassicasterol and 24-methylene-cholesterol tracing diatom inputs in settling particles in mid-waters (full circles) and deep waters (open circles)

The concentrations and fluxes of diatom-biomarkers clearly depict the temporal patterns of downward organic carbon fluxes, suggesting that diatom production exert a main control on carbon export. Besides, diatom biomarkers also portray the temporal variability of opal fluxes. Very high amounts and fluxes of alkenones are observed, consistent with the important coccolithophorid production (mainly *Emiliania huxleyi)* in the Black Sea. The temporal patterns delineate a major coccolithophorid bloom in spring 08 that contributes to the organic carbon fluxes and clearly controls the carbonate flux variability. In addition, dinosterol and diols trace inputs from dinoflagellates and nannoplankton species that show important temporal variation. Biomarkers derived mainly from zooplankton (e.g. cholesterol) show elevated concentrations and fluxes in time intervals characterised by very abundant phytoplakton-biomarkers. Thus, the downward transfer of marine organic carbon appears to be linked to significant zooplankton grazing. Comparisons between the mid-depth and deep traps show that the transfer is rapid and that carbon recycling is not very important, leading to enhanced carbon sequestration in this marine site. Overall, the biomarker data-set sheds light on the origin of organic carbon in settling particles in the SW Black Sea and enables determining its major marine sources linked to the primary production. Biomarker temporal variability allows explaining the patterns of the export organic carbon (but also carbonate and opal) and assessing primary controls on downward fluxes.

References

1 - Gogou A., Bouloubassi I., Lykousis V., Arnaboldi M., Gaitani P. and Meyers P.A., 2007. Organic geochemical evidence of Late Glacial-Holocene climate instability in the North Aegean Sea. Palaeogeography, Palaeoclimatology, Palaeoecology, 256: 1-20.

CONCENTRATIONS DES MÉTAUX TRACES DANS LA CHAIR DE DONAX TRUNCULUS (MOLLUSQUE, BIVALVE) DES CÔTES SABLEUSES DU GOLFE DE TUNIS

Dhouha Boussoufa [1]*, Nabila Ghazali [1] and M'hamed El Cafsi [1]

[1] Unité de Physiologie et d'Ecophysiologie des Organismes Aquatiques, Faculté des Sciences de Tunis, 2092, Tunisie - d.boussoufa@yahoo.fr

Abstract

Une étude saisonnière des teneurs en zinc (Zn), cuivre (Cu), plomb (Pb) et cadmium (Cd) a été effectuée chez le mollusque bivalve Donax trunculus récolté dans les côtes sableuses de trois stations du Golfe de Tunis : Kalâat El Andalous (KA), Radès (R) et Borj Cedria (BC). Les résultats ont montré que les concentrations en métaux analysés diminuent dans l'ordre suivant : Zn > Cu > Pb > Cd, dans les trois stations. La bioaccumulation en Zn, Pb et Cd est pratiquement la même chez les individus des trois sites. À l'exception du Pb, nous avons enregistré une variation saisonnière des teneurs en métaux analysés dans les trois stations.

Keywords: Bivalves, Pollution, Trace Elements

Introduction

Au cours de ces dernières décennies, l'activité anthropique (industrielle, économique) a entraîné une augmentation continue des concentrations des éléments métalliques dans l'environnement marin. En effet, les stations étudiées localisées au niveau du Golfe de Tunis ont été sélectionnées dans le but d'évaluer l'impact des rejets d'oueds (Medjerda, Méliane et Soltane qui débouchent respectivement dans la plaine de [KA], [R] et [BC]) sur les organismes aquatiques qui vivent dans ces sites. Dans ce travail, une attention particulière est portée sur le suivi de l'évolution de la teneur en Cd, Pb, Zn et Cu au niveau de la chair du mollusque bivalve *Donax trunculus*.

Matériel et méthodes

Les échantillons ont été prélevés dans les stations d'étude durant la période allant de juillet 2004 à mai 2005. Le dosage des métaux a été effectué par un spectrophotomètre d'absorption atomique avec flamme (Air acétylène). L'indice de pollution métallique (MPI) a été utilisé [1] pour déterminer le degré de pollution de chaque station. Il est obtenu par l'équation : $MPI=(CF_1xCF_2x\ldots\ldots CF_n)^{1/n}$, où CF_n est la concentration du métal (n) dans l'échantillon. Les concentrations en métaux analysés sont exprimées en mg/Kg du poids sec. La significativité des différences entre les moyennes a été analysée par ANOVA.

Résultats et discussion

Les résultats de cette étude (tableau 1) ont montré que les Donax de chaque station accumulent différentes quantités de métaux dans leurs tissus et que le Zn et le Cu sont les métaux les plus abondants. Dans un ordre de significativité ($p \leqslant 0,05$), le Zn et le Cu sont suivis par le Pb. Les concentrations de ces métaux sont similaires à celles obtenues chez d'autres bivalves [1]. L'élément qui présente les concentrations les plus faibles dans les deux populations de Donax est le Cd. Pour le Zn, le Pb et le Cd, aucune différence significative ($p \leqslant 0,05$) n'a été signalée entre les Donax des trois stations. Quant au Cu, les concentrations enregistrées dans la station de KA sont significativement plus élevées que celles enregistrées dans R ($p \leqslant 0,001$) et BC ($p \leqslant 0,01$). La variation saisonnière de la teneur en Pb est peu importante. Cependant, les concentrations printanières en Zn et Cu des Donax de KA diffèrent significativement ($p \leqslant 0,05$) des concentrations enregistrées durant les autres saisons. Quand au Cd les teneurs signalées sont souvent faibles ou non détectables hormis le pic printanier chez les Donax de R (0,66±0,01) et le pic automnal des Donax de BC (0,64±0,18) qui sont les plus importants ($p \leqslant 0,001$). Le calcul de l'indice de pollution métallique MPI a montré que le MPI des Donax de BC est supérieur à celui de R et KA. Ces ions métalliques accumulés au niveau de la chair de Donax proviennent, probablement des eaux usées non traitées, industrielles et urbaines qui amènent des quantités considérables de métaux et ce par le biais des oueds Medjerda, Méliane et Soltane qui débouchent au niveau des endroits très proches de nos stations.

Selon les normes européennes [2] qui ont été fixées pour autoriser la consommation de ces organismes (Pb: 1.5 mg/kg, le Cd: 1 mg/kg et le Zn: 100 mg/kg de poids frais), nous pouvons dire que les Donax de cette étude ont des teneurs en Pb, Cd et Zn inférieures à la limite des teneurs tolérées pour la consommation humaine.

Tab. 1. Variations saisonnières des concentrations en métaux lourds (mg /kg poids sec) de la teneur en eau (%) et de l'indice de pollution métallique (MPI) chez le bivalve Donax *trunculus* récolté dans les trois stations: R., KA. et BC

Sites	Pb	Zn	Cu	Cd	MPI	Teneur en eau
Eté R	3,36	81,15	6,32	< 0,1	3,62	82,24
Automne R	4,61	74,16	5,76	< 0,1	3,74	73,25
Hiver R	4,84	86,98	6,34	0,1	4,04	76,02
Printemps R	4,23	81,93	6,73	0,66	6,26	73,68
Eté KA	4,03	76,17	10,65	< 0,1	4,25	87,71
Automne KA	3,51	68,27	9,64	0,1	3,89	78,88
Hiver KA	5,11	77,67	12,33	< 0,1	4,70	81,34
Printemps KA	3,48	87,46	15,3	0,27	5,95	78,71
Eté BC	3,59	80,83	8,41	< 0,1	3,95	79,49
Automne BC	5,36	78,57	8,69	0,64	6,95	78,84
Hiver BC	3,36	85,12	10,32	< 0,1	4,14	78,28
Printemps BC	4,14	83,64	11,86	0,12	4,71	75,22

References

1 - Usero J., Gonzàlez-Regalado E., Gracia I., 1997. Trace metals in the bivalve molluscs Ruditapes decussatus and Ruditapes philippinarum from the Atlantic Coast of Southern Spain. *Environment International*. 23: 291-298.

2 - European communities, 2001. Commission regulation (EC) No 466/2001 of 8 March 2001 setting maximum levels for certain contaminants in foodstuffs; *official Journal of the European communities* L77

HYDROCARBONS LEVELS IN MOLLUSCS (BIVALVES) IN THE MOROCCAN WESTERN MEDITERRANEAN SEA

Saïda Bouzid [1]*, Hassan Er-Raioui [1], Ioanna Bouloubassi [2] and Alain Saliot [2]
[1] Equipe Géosciences et Environnement, Département de Sciences de la terre. Faculté des Sciences et Te - sur24@yahoo.fr
[2] Laboratoir LOCEAN, université Pierre et Marie Curie, Paris 6

Abstract
The Moroccan north-western coasts receive continually high inputs of organic matter mostly anthropogenic, from ship and boat traffic discharges and untreated sewage and waste water discharges. So, it was urgent to assess the degree of contamination by hydrocarbons in the zone from Fnideq to Kaâ Asrass, using biota samples (cockles). In this investigation, the study of hydrocarbons is based on the analysis of chemical indicators (n-alkanes hydrocarbons, isoprenoids, hopanes, LAB) to characterize the contamination's sources (biogenic and petrogenic).
Keywords: Bivalves, Chemical Analysis

Material and methods
Sampling On spring 2003, samples of *Acanthocardia tuberculata* commonly known as cockles, were collected from 7 sites at the western moroccan mediterranean sea.
The bivalves have been immediately shelled, crushed and freeze-dried. *Hydrocarbon analysis* Entire organisms tissues were crushed, freeze-dried and soxhlet extracted (5g) with methanol for 10h. Perdeuterated internal standard (n-C24D50) was added before the extraction. The saponification of the lipid extract was performed with KOH/distilled water (0.7N, 2:3) for 2h. Afterwards liquid/liquid extraction was made with n-hexane 3 times. The lipid extract was concentrated and separated by column chromatography on neutral alumina/silica (v: v) (5% deactivated) and eluted, with 20ml n-hexane. The F1 fraction corresponding to aliphatic hydrocarbons was concentrated under vacuum evaporation to dryness and then re-dissolved in 50 µl prior to the analysis by gas chromatography GC/FID and GC/MS.

Preliminary Results
The distribution of n-alkane in all samples shows a trace of terrestrial biogenic inputs, (important peak n-C27 and n-C29) [1]. n-C17 was detected in some samples, it indicate a phytoplanctonic origin [2]. It also shows an important presence of n-C18 and n-C20 related to bacterial origin [3]. UCM was present in the lower molecular weight range, linked to bacterial degradation of natural organic inputs [4]. Moreover, the CPI close to unity suggests an oil contamination [5]. Prystane was absent in most samples except for the O2 site. Inversely to Phytan, it was absent only in O8 site. The Ratios C17/Pr and C18/Py > 1 indicate a petrogenic contribution which is also confirmed by Pr/Py<1. On the other hand, hopanes series were determined in the GC/MS by monitoring m/z 191 in some samples collected from the study area.The identified component had the thermodynamically stable 17α(H), 21β(H) configuration which is indicative of pollution from fossil fuel products [6]. A series of peaks were identified as being the linear alkylbenzene (LAB). They are used as raw material for synthesizing linear alkylbenzene sulfonates (LAS), which are the anionic surfactants commonly used in synthetic detergents [5]. The concentration of total LAB is summered in the Table. such levels were reported by [6, 7, 5].

References
1 - Le Dréau Y., Jacquot F., Doumenenq P., Guiliano M., Bertrand J.C., Mille G., 1997. Hydrocarbon balance of a site which had been highly and chronically contaminated by petroleum wastes of a refinery (from 1956 to 1992). *Mar. Pollut. Bull*., 34: 456-468.
2 - Saliot A., 1981. Natural hydrocarbons in the sea water. In: Duursma E, Dawson R, (ed). Marine orgnic chemistry. Amsterdam: Elseivier, pp 233-74.
3 - Nishimura M. and Baker E.W., 1986. Possible origin of n-alkanes with a remarkable even-to-odd predominance in recent marine sediments. *Geochim. Cosmochim. Acta.*, 36: 709-727
4 - Venkatesan M.I., Kaplan I.R., 1982. Distribution and transport of hydrocarbons in surface sediments of the Alaskan outer continental shelf. Geochim. *Cosmochim. Acta*., 46: 2135-2149.
5 - Medeiros P.M., Bicego M.C., Castelao R.M., Del Rosso C., Fillmann G., Zamboni A.J., 2005. Natural and anthropogenic hydrocarbon inputs to sediments of Patos Lagoon Estuary, Brazil. *Environ. Interna*., 31: 77-87.
6 - Bouloubassi I, Saliot A., 1993. Investigation of anthropogenic and natural organic inputs in estuarine sediments using hydrocarbon markers (NAH, LAB, PAH). *Oceanol Acta*.,16:145–61.
7 - Raymundo C.C., Preston M.R., 1992. The distribution of linear alkylbenzenes in coastal and estuarine sediments of the Western North Sea. *Mar. Pollut. Bull*. 24: 138– 46.

CHARACTERISTICS OF STABLE ISOTOPE EMPIRICAL DISTRIBUTIONS IN PRECIPITATION AT CENTRAL EUROPEAN GNIP STATION - LJUBLJANA, SLOVENIA

Mihael Brencic [1]* and Polona Vreca [2]
[1] Department of Geology, University of Ljubljana - mihael.brencic@ntf.uni-lj.si
[2] Department of Environmental Sciences, Jožef Stefan Institute, Jamova cesta 39, SI-1000, Ljubljana

Abstract
Empirical distributions of hydrogen and oxygen stable isotope time series at Ljubljana – Slovenia GNIP precipitation station has been explored. Results show bimodal empirical distribution of hydrogen and oxygen stable isotope data. Bimodal distribution was described as representation of the two populations modelled by two component mixture of Gaussian distributions. The mixture of two populations was described as discrete event by seasonality dependent bimodal distribution.
Keywords: Time Series, Geochemistry, Geochemical Cycles

Introduction

Precipitation can be described as stochastic process that varies temporarily and spatially; it can be expected that their chemical and isotopic characteristics can be described in the similar way. Literature abounds on stochastic modelling of precipitation amount and intensity time series; however stochastic models dealing with chemical characteristics of precipitation are few and stochastic modelling of isotopic time series is even more in the background. The intention of the paper is therefore to explore stochastic characteristics of hydrogen and oxygen stable isotope time series.

Methods

Stochastic characteristics are represented on the hydrogen and oxygen stable isotope time series of Ljubljana precipitation. Ljubljana is a GNIP-network precipitation station where composite monthly precipitations samples are collected. Operation of the Ljubljana station started on May 1981 and proceeds until today. It is central European station where influences of the precipitation originating from Atlantic and Mediterranean air masses are present. Average LMWL is close to GMWL. [1], [2] On the monthly data values exploratory analyses was performed and kernel densities were calculated.

Results

Results show that empirical distribution of both data series is bimodal. Bimodality of empirical distribution $p(x)$ was model as two component mixture of Gaussian distributions $f(x|\mu_1,\sigma_1)$ and $f(x|\mu_2,\sigma_2)$ with parameters μ_i,σ_i. The model can be described as $p(x)=af(x|\mu_1,\sigma_1)+(1-a)f(x|\mu_2,\sigma_2)$ where the appearance of particular component was modelled as discrete event by seasonality dependent bimodal distribution.

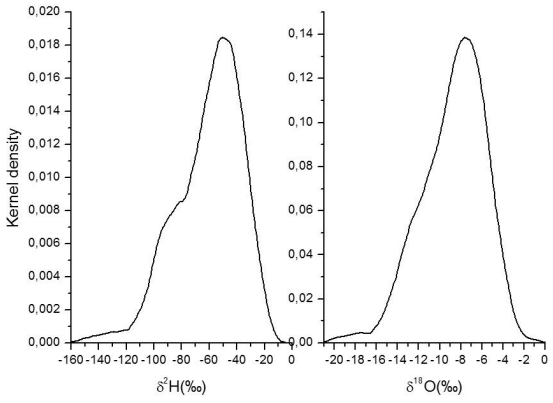


Fig. 1. Kernel densities of oxygen and hydrogene stable isotope composition at GNIP Ljubljana station

Discussion

The model is interpreted as mixing of the Atlantic and Mediterranean are masses in the approximate share of 3:1.

References
1 - Vreca P., Krajcar Bronic I., Leis A., Brencic M., 2008. Isotopic composition of precipitation in Ljubljana (Slovenia). *Geologija*, 51: 169-180.
2 - Vreca P., Krajcar Bronic I., Horvatincic N., Baresic, J., 2006: Isotopic characteristics of precipitation in Slovenia and Croatia: Comparison of continental and maritime stations. *Journal of Hydrology*, 330: 457-469.

MODELLING ORGANIC MATTER OXIDATION UNDERNEATH A MEDITERRANEAN MUSSEL FARM

D. Brigolin [1]*, P. Regnier [2], F. Rampazzo [3], M. Giani [4], S. Predonzani [5], S. Covelli [6] and R. Pastres [1]
[1] Dept. of Physical Chemistry, Ca' Foscari University of Venice - brigo@unive.it
[2] Dept. Earth Sciences, Utrecht University; Dept . Earth & Environmental Sciences, University Of Brussels
[3] ISPRA, Istituto Superiore per la Protezione e la Ricerca Ambientale, Chioggia
[4] Oceanography Dept. OGS, Istituto Nazionale di Oceanografia e Geofisica Sperimentale
[5] Environmental Protection Agency, F. V. Giulia
[6] DISGAM, University of Trieste

Abstract
Mussel biodeposits accumulation and oxidation were studied by means of 3 different numerical models: an early diagenetic model, a population dynamic model and a deposition model. Models were applied at a long-line farm located in the Northern Adriatic Sea by using a dedicated set of field data. Both field data and model results showed that biogeochemical alterations induced by the mussel farm are markedly lower compared to the extent of the impacts commonly reported for fish cages. Nevertheless, a model sensitivity test indicate that organic matter flux, sediment geochemistry and nutrient recycling can vary remarkably as a function of the stock of the mussels and the environmental forcings scenario considered.
Keywords: Aquaculture, Models, Organic Matter, Bivalves, Adriatic Sea

Introduction During the last two decades, shellfish production raised questions concerning the environmental impact and sustainability of shellfish farms, at both local and regional scales [1]. Numerical models have proven to be useful science-based tools for site-selection and ecological carrying capacity assessment [2]. Models capable to represent the interactions of mussel biodeposition with sedimentary redox processes are currently lacking in the field of aquaculture, although monitoring techniques based on biogeochemical measures were found to be more cost-efficient than the ones based on macrofaunal community structure [3]. The main objective of this work was to study the applicability of a novel approach to model the interaction between mussel farm biodeposition, sediment geochemistry and nutrient recycling.

Methods Vertical profiles of sediment porosity, and concentrations of organic carbon, NH_4^+, NO_3^{2-}, SO_4^{2-}, dissolved inorganic P, Mn^{2+} and Fe^{2+} were collected at a mussel farm located off-shore Chioggia (approximately 20m depth). Two field campaigns were carried out at two stations located underneath the farm, in February and July 2007. Radiometric dating analysis was carried out on cores collected underneath the lines in order to assess the sedimentation rate. N:C and P:C elemental ratios were determined on the faeces produced from a set of individuals (180) collected from a marked rope along 8 field campaigns (July 2006 - May 2007). A current-meter was deployed from July to September 2006 and from April to May 2007. Mussel density and husbandry practices were estimated on the basis of regular interviews with the farmers [4]. The standing-stock of the mussels and the production of biodeposits were simulated through a population dynamic model (PDM) of *M. galloprovincialis* [5]. The OM rain underneath the mussel farm was estimated by means of 3D particle tracking models [6]. Aerobic and anaerobic pathways of organic matter (OM) oxidation were modelled by means of a 1D reaction-transport early diagenetic model [7]. The diffusive fluxes of dissolved constituents at the sediment-water interface were calculated on the basis gradients of their concentrations. Model application was carried out in three steps: 1)the flux of OM from the farm was estimated through an inverse use of the early diagenetic model: this was calibrated by minimising the distance between predicted profiles and field data, under a set of constraints; 2)the OM flux from the farm was independently estimated by coupling the population dynamic and particle-tracking models; 3)different sensitivity tests were carried out, in order to study the potential impact of the mussel farm, associated with the different scenarios of mussel standing-stock, bathymetry and hydrodynamic regimes.

Results and discussion The flux of OM originated by the farm, estimated by calibrating, Fig. 1, the early-diagenesis model was of approximately 15 g C m^{-2} y^{-1}, lower but comparable with the fluxes estimated by coupling the population dynamic and particle-tracking models (Fig. 1). These fluxes are lower than the range measured by [8] underneath a mussel farm located in a Canadian lagoon, 20-150 g C m^{-2} y^{-1}. Results from the particle tracking model indicate that ~ 95% of OC deposited within 500m from the farm boundaries, on a total surface of 6.5 km^{-2}. As regards oxygen penetration depth, TS concentrations and dissolved nutrients profiles, results indicate that the impact of a mussel farm per unit area is markedly lower than the one induced by finfish cage farming. However, the overall impact of OM oxidation on the N and P cycles can be regarded as significant, given the extension of the licensed areas. Results from the sensitivity tests, indicate that the entity of the impact can vary dramatically in response to the scenario considered, suggesting the potential use of this type of models as decision support tools for site-selection and farm dimensioning.

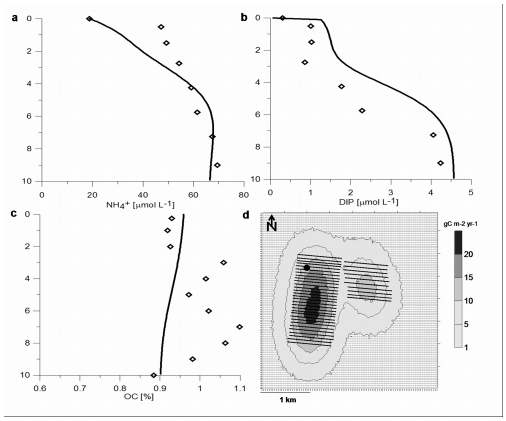


Fig. 1. A-c) Early diagenetic model calibration: predicted profiles versus field data; d) Population dynamic model and particle tracking model results.

References
1 - Kaiser M.J., 2000. Ecological effects of shellfish cultivation. *In*: Black K.D. editor. Environmental impacts of aquaculture. Sheffield Academic press, pp. 51-75.

2 - McKindsey C.W., Thetmeyer H., Landry T., Silvert W., 2006. Review of recent carrying capacity models for bivalve culture and recommendations for research and management. *Aquaculture*, 261: 451-462.

3 - Wildish D.J., Hargrave B.T., Pohle G., 2001. Cost-effective monitoring of organic enrichment resulting from salmon mariculture. ICES, *J Mar Sci*, 58: 469–476.

4 - Pastres R., Pranovi F., Brigolin D., Rampazzo F., Giani M., Giovanardi O., Savelli F., Berto D., Franceschini G., 2008. ECASA Study Site Report, Chioggia (Italy). http://www.ecasatoolbox.org.uk (accessed 13.11.09).

5 - Brigolin D., Dal Maschio G., Rampazzo F., Giani M. and Pastres R., 2009. An individual-based population dynamic model for estimating biomass yield and nutrient fluxes through an off-shore mussel (*Mytilus galloprovincialis*) farm. *Estuar Coast Shelf S*, 82: 365-376

6 - Jusup M., Gecek S., and Legovic T., 2007. Impact of aquacultures on the marine ecosystem: Modelling benthic carbon loading over variable depth. *Ecol Model*, 200: 459-466.

7 - Aguilera D.R., Jourabchi P., Spiteri C. and Regnier P., 2005. A knowledge-based reactive transport approach for the simulation of biogeochemical dynamics in Earth systems. *Geochem Geophy Geosy*, 6: Q07012.

8 - Callier M.D., Weise A.M., McKindsey C.W., Desrosiers G., 2006. Sedimentation rates in a suspended mussel farm (Great-Entry Lagoon, Canada): biodeposit production and dispersion. *Mar Ecol Prog Ser*, 332: 129-141.

LAND BASED AND SHIP ORIGINATED POLLUTION IN THE TURKISH STRAITS SYSTEM

Selmin Burak [1]*, Sibel Zeki [1], Volkan Demir [1] and Ertugrul Dogan [1]
[1] Istanbul University, Institute of Marine Sciences and Management - sburak@istanbul.edu.tr

Abstract
Until the early 1970's the Turkish Straits System was one of the richest and most productive marine environments in the world [1]. Due to pollution stemming mainly from land-based pollution and maritime traffic, this sensitive ecosystem is now facing the threat of degradation.
Keywords: Marmara Sea, Bosphorus, Pollution

Introduction
It has been estimated that on a global scale, up to 70% of pollution in the seas originate from land-based sources [2]. The marine environment of the Marmara Sea has become increasingly vulnerable; whose oceanographic features do not help much its self-purification capacity. This inland sea is a semi-enclosed water body of 11111 km^2 with an average depth of 260m connecting the Mediterranean and the Black Sea via the Canakkale (Dardanelles) and Istanbul Straits. Domestic pollution load is generated mainly by the Istanbul Metropolis and its surroundings where 1/5 of Turkey's population live [3]. Furthermore large industrial facilities amounting to 60 % of the total, located on the bays and coastal areas constitute the most significant portion of local land-based input into the Marmara Sea. Additionally the marine environment of the Istanbul Strait and Marmara Sea is confronted with severe environmental degradation due to ship-originated pollution generated mainly by the bilge/ballast waters of tankers and cargo vessels.

Material and Method
The study was carried out in the Istanbul Strait and Marmara Sea (Figure 1). The water quality monitoring sampling frequency of the Istanbul Strait was designed to monitor the sea water quality on a monthly basis at the monitoring stations, whereas the Marmara Sea stations were followed on seasonal basis for a comprehensive set of parameters enabling the identification of the physical, chemical, biological state of the marine environment for all the stations.

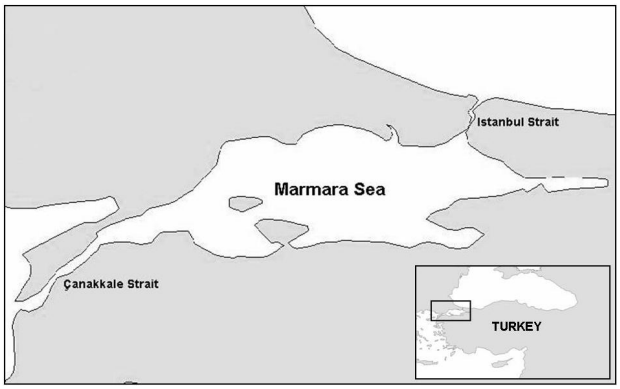


Fig. 1. Study area

Results
The land-based pollution load for the Marmara Sea generated by major hotspots was calculated during the compilation of the Istanbul Master Plan study. DHI found out that the major hot-spots is Istanbul (contributing with almost 65% of the total land-based pollution to the Marmara Sea) [4]. The Marmara region is the most developed in terms of industrialization, with a wide variety of industries concentrated in the Gulf of Izmit, Gemlik and around Istanbul. The build-up effect of pollution has started to spread over the continental shelf, giving rise to a widespread deterioration of the natural balance in the marine ecosystem. Difficult natural conditions such as the intricate geometry of the Istanbul Strait, sharp turns on the navigation route, harsh meteorological conditions and transient changes in the flow regime coupled with increasingly dense maritime traffic create a serious risk of accident. Significant amounts of crude oil spill have been the major cause of ecological damage experienced so far as a consequence of maritime accidents. The ecological hazard generated by oil spill has resulted in the decrease and/or extinction of surface and subsurface fish species and crustaceans.

Discussion
The experimental results of a ten-year monitoring, study from the year 1996 to the year 2005, indicates an improvement with regard to nutrient load in the surface waters of the Marmara Sea after the commissioning of the deep-sea outfalls. But there is still incremental and point source pollution in the Marmara Sea with high phytoplanktonic activity. Therefore, pollution is still a concern for the receiving waters of Istanbul and in the Marmara Sea basin in general despite large investment expenditures allocated to Istanbul [5,6]. The accidents caused by tankers and cargo ships resulting in loss of human life, property and damage to the environment have been creating great public concern. Pollution derived from the maritime traffic in the Istanbul Strait and Marmara Sea is no exception. Besides sea accidents, illegal practices such as pumping of bilge and waste water, and unloading of dirty oil and garbage by transit vessels in particular, contribute to marine pollution, which also affects recreational beaches [7].

References
1 - Turkish Ministry of Environment, 2002. The Mediterranean Action Plan in Turkey, Towards Sustainable Development. Turkish Ministry of Environment Foregin Relations Department, Ankara, Turkey.
2 - UNEP, 1990. GESCAMP: State of the environment. UNEP Regional Seas Reports and Studies, No. 115, UNEP, Nairobi.
3 - Burak S., 2008. Evaluation of Pollution Abatement Policies in the Marmara Sea with Water Quality Monitoring. *Asian Journal of Chemistry*, 20 (5): 4117-4128.
4 - Danish Hydraulic Institute, 1994. 3D, Numerical Modeling of the Environmental Conditions of the Seas around Istanbul (Final Report). DHI, Denmark.
5 - Sur H.I, Okus E., Güven K.C, Yüksek A., Altiok H., Kiratli N., Unlu S., Tas S., Aslan-Yilmaz A., Yilmaz N., Ovez S., Muftuoglu A.E., Karhan U., Oz I. and Demirel N., 2004. Water Quality Monitoring, Annual Report 2003.
6 - ISKI, 2002. Istanbul Water and Sewerage Administration, Annual Report 2002.
7 - Dogan E. and Burak S. 2007. Ship-Originated Pollution in the Istanbul Strait (Bosphours) and Marmara Sea. *Journal of Coastal Research*, 23 (2): 388-394.

CARBONATE SYSTEM DYNAMICS IN THE GULF OF TRIESTE (NORTH ADRIATIC SEA)

C. Cantoni [1]*, A. Luchetta [1], S. Cozzi [1], M. Celio [2] and G. Catalano [1]
[1] CNR Institute of Marine Sciences (ISMAR), Trieste, Italy - carolina.cantoni@ts.ismar.cnr.it
[2] ARPA - Friuli Venezia Giulia, Palmanova (UD), Italy

Abstract
We present first results of a study started in January 2008 and focused on the analysis of the variability of carbonate system in the Gulf of Trieste (N. Adriatic Sea). Total alkalinity, pH, and mayor physical and biogeochemical parameters were measured at PALOMA station (centre of the Gulf). We evidenced the role of direct inorganic carbon riverine inputs, sea water temperature and production / regeneration processes as mayor drivers of the observed carbonate system variability during the studied period.
Keywords: Adriatic Sea, Ph, Coastal Systems, Carbon

Introduction
The Gulf of Trieste (Adriatic Sea) is the Northernmost area of the Mediterranean which, as other sub-tropical continental shelf areas, experiences a strong seasonal cycle. Here, the pronounced cooling of the coastal waters during winter (7-8°C) and the mixing due to Bora wind events increases the solubility of CO_2 in water, permitting its potential sequestration in the denser bottom waters by the mechanism of the physical carbon pump. In summer, the warming of surface waters (28°C) and the scarce circulation may invert the flux of CO_2 with the atmosphere, particularly during period of low primary production. Because of the low inertia of this shallow coastal ecosystem compared to the deep sea and of its pronounced seasonal cycle, the Gulf of Trieste is thought to be highly sensitive toward the climate changes and the global atmospheric CO_2 rising. For this reason, the increase of CO_2 dissolved in seawater and the consequent decrease of pH might lead in this area to earlier changes of the marine environment due to ocean acidification than elsewhere.
We present first results of a study started in January 2008 and focused on the analysis of the variability of carbonate system in the Gulf of Trieste with respect to riverine inputs, sea water temperature and production / regeneration processes.

Methods
Since January 2008, pH, Total Alkalinity (TA) and physical/chemical parameters were acquired on monthly basis, on the whole water column at the site PALOMA (centre of the Gulf, 25m depth, close to the dynamic pylon PALOMA – Advanced Oceanic Laboratory PlatforM for the Adriatic sea). pH have been measured by the spectrophotometric method [1,2] with a precision of ± 0.001 and the results were expressed on "total scale" in $\mu molH^+/Kg_{SW}$ at 25°C (pH_T@25°C). TA has been measured by potentiometric titration at 25° C (precision ± 2 µmol/kg) and the results were controlled with sea water certified as reference material (supplied by dr. A.G. Dickson). The other parameters of the carbonate system (pCO_2, pCO_2@15C°, DIC, Revelle factor, "Omega"Ar, "Omega"Ca) were computed from pH, TA, salinity, temperature, SiO_2, PO_4 with the "CO2sys" program. To our knowledge this is the first time serie of this set of parameters collected in the N. Adriatic Sea.

Results and Discussion
From October to March, the water column was homogeneous and well ventilated. pH_T@25°C was generally low and constant (avg 7.920), because of the increased CO_2 solubility caused by the low water temperature (down to 8.0°C) and by the exceeding respiration compared to primary production. During the stratified period of both years (April – Sept.), the combined effect of high temperature and CO_2 assimilation in the upper waters determined the highest values of pH_T@25°C (Tab 1). In contrast, the remineralization processes in the bottom layer (Apparent Oxigen Utilization – AOU = 142 µM) prevailed on the effect due to the high water temperature (18.9°C) determining the lowest values of pH_T@25°C observed during the whole time series (Tab 1).
TA concentrations (Tab 1) were higher than in open Mediterranean sea (~ 2600 µmol/Kg [3]) due to the inflow of rivers with a carbonatic drainage basin. TA variability was mainly modulated by riverine inputs with variable TA concentrations and by the occurrence of strong remineralization processes in the bottom layer (Aug.- Nov. 2008, up to 2693 µmol/kg) as shown by the relationship with AOU.
The seasonal evolution of in situ pCO_2 was deeply influenced by the variations of temperature. Despite the production processes in the upper water column, the effect of temperature increased pCO_2 at values higher than 400 µatm on the whole water column, from August to December 2008. In contrast, its values were always lower than 350 µatm from January to June 2009. If we assume an average value of 380 µatm for atmospheric CO_2 concentrations, the Gulf of Trieste was supersaturated from August to December 2008, acting as a potential source of CO_2 for the atmosphere; on the contrary surface waters were undersaturated from January to June 2009 acting as a potential CO_2 sink.
An exception to this trend was the high pCO_2 value (523 µatm) observed in April 2009, in surface low salinity waters (S=27.6), which was ascribed to the ventilation of CO_2 from supersaturated riverine waters.
The superficial pCO_2@15C° values were compared with those reported from other European coastal zones [4]. From the relatively few data collected, pCO_2@15°C presented a clear seasonal cycle with lower values in summer (258 µatm) and higher in winter (495 µatm) wiht an amplitude of 236 µatm. This cycle was more similar to what reported for the North Sea coastal zones than to the olygothrophic coastal site studied in the western Mediterranean.
Despite the high alkalinity, the pronounced variability of Revelle factor and of "Omega" Ca and Ar evidence the overall weak buffering capacity of carbonate system in the Gulf of Trieste.

Tab. 1. Average values and variability of carbonate system parameters at PALOMA station on an annual cycle: Aug08-Juy09.

	pH_T (25°C)	TA (25°C) µmol/Kg	pCO_2 µatm	pCO_2 (15°C) µatm	DIC µmol/Kg	ΩCa	Ω Ar	Rev.
Avg	7.947	2652	418	406	2365	4.96	3.20	10.91
Med	7.946	2647	381	394	2352	4.86	3.11	10.82
Max	8.109	2859	1047	895	2651	6.67	4.37	14.88
Min	7.648	2624	291	258	2281	2.76	1.79	9.24

References
1 - R.H. Byrne and J.A. Breland, 1989. High precision multi-wavelenght pH determination in seawater using cresol red. *Deep-Sea Res.*, 36: 803-810.
2 - A.G. Dickson, C.L. Sabine and J.R. Christian (Ed), 2007.Guide to best practices for ocean CO_2 measurements. Sop 6b. PICES Special Publication 3, pp 191.
3 - A. Schneider, D.W.R. Wallace, A. Körtzinger, 2007.Alkalinity of the Mediterranean Sea. *Geophys. Res. Lett*., 34: L15608.
4 - A.V. Borges, L.-S. Schiettecatte, G. Abril, B. Delille, F. Gazeau., 2006. Carbon dioxide in European coastal waters. Estuarine, *Coast. Shelf Sci*., 70: 375-387.

HEAVY METALS DISTRIBUTION IN MARINE SEDIMENTS OF THE EAST ADRIATIC SEA

Ana Castelli [1]* and Zoran Kljajic [1]
[1] Institute of Marine Biology - ana.bulatovic@t-com.me

Abstract

Heavy metals (Cd, Pb, Cu, Zn and Ni) concentration and distribution were determined in marine sediments along the Montenegrin coast in the East Adriatic as there is luck of historical, continuous data about heavy metals pollution of this area. The distribution shows that metals concentration decrease in the sediment samples from SE to NW along the coast. The concentrations are generally not high, revealing that the investigated coastal area is not polluted.

Keywords: Adriatic Sea, Metals, Sediments

Introduction

Sediments are usually regarded as the ultimate sink for heavy metals discharged into the marine environment, thus determination of the distribution and concentrations of the heavy metals in sediments is of great importance in environmental pollution studies [1]. The study area is the Montenegrin coast which belongs to the Eastern South Adriatic. The Adriatic Sea is located in the central-north part of the Mediterranean Sea. It is relatively shallow sea especially subjected to pollution due to its semi-enclosed character [2]. Heavy metals in the surface sediments from Montenegrin coast may originate either from natural sources (weathering, pluvial and fluvial erosion), but also from anthropogenic sources (e.g. industrial and municipal effluents, port activities, traffic, rivers, atmospheric inputs). Surface sediment samples collected from the seven near-shore and off-shore stations along the Montenegrin coast were analyzed for Cd, Pb, Cu, Zn and Ni. In the investigated area seven stations (Figure 1) were selected from the entrance of the Boka Kotorska Bay to the mouth of the Bojana river in order to estimate level of concentrations and to present spatial distribution of chosen metals that are mostly associated with anthropogenic inputs [1].

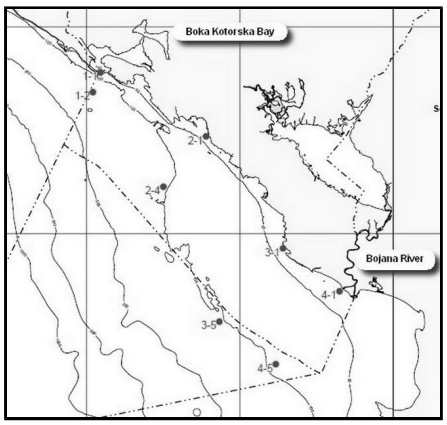


Fig. 1. The investigated area with sediment sampling sites

Meterials and methods

Seven sediment samples (on location 2-1 was sand) were taken in November 2007 with italian research vessel "G. Dallaporta" by using box corer. Concentration of Cd, Pb, Cu, Zn, and Ni in surface sediment samples were determined by Energy Dispersive Polarised X-ray Fluorescence (EDPXRF).

Results and discussion

Metal concentrations in the sediment samples (dry weight) range from 10.64 to 24.35 mg/kg for Pb, from 0.0893 to 0.2713 mg/kg for Cd, from 61.43 to 109.40 mg/kg for Zn, from 20.46 to 44.30 mg/kg for Cu and from 172.69 to 325.70 mg/kg for Ni. Minimal concentration of investigated metals was registered in front of the entrance of the Boka Kotorska Bay on locations 1-1 (Cu, Zn, Ni) and 1-2 (Cd). The exception is Pb which minimal concentration was found on location 3-1. All examined metals had maximal concentration on position 4-5 which is located 14.5 km from the mouth of the Bojana river. Comparing near and off-shore concentrations for Pb, Cd, Cu, Zn and Ni it can be noticed that all metals have shore side concentration less than metal concentrations distant from the coast. The obtained concentrations for Pb, Cd, Cu and Zn are comparable or less than those reported for sediments from different parts of the Adriatic ([3], [4]). According to some sediment quality criteria ([5], [6]), low concentrations of the examined metals indicate that investigated sediment is not polluted. Exception is Ni which level is higher than in the surroundings.

Conclusion

The distribution shows decreasing concentration trend for all metals going in SE-NW direction along the coast and increasing concentration trend with the distance from the shore side. This can be explained with the influence of the Bojana river inside and outside of its estuary, as well as with general anti-clockwise circulation of the Adriatic waters. Comparisons indicate that sediment of the examined area is not polluted.

Acknowledgement

Sediment samples were collected during oceanografic cruise within the joint Italian-Montengrin project ADRICOSM STAR, supported by Italian Ministry for the Environment, Land and Sea and Montenegrin Ministry for spatial planning and environment (2007-2010).

References

1 - Baker A.R., 1980. Contaminants and Sediments, Volume I - Fate and transport, Case Studies, Modeling, Toxicity. Ann Arbour Science Publ., Michigen, pp 119-139.

2 - Dolenec T., Faganeli J., Pirc S., 1998. Major, Minor and Trace Elements in Surficial Sediments from the Open Adriatic Sea: A Regional Geochemical Study. *Geol. Croat.*, 51/1: 59-73.

3 - Bogner D., Ujevic I., Baric A., 2005. Trace Metal (Cd,Pb,Cu,Zn and Cr) distribution in sediments along East coast of the Adriatic Sea. *Fresenius Environ. Bulletin.,14: No 1*

4 - Obhodjas J., Kutle A., Valkovic V., 2006. Concentrations of some elements in the coastal sea sediments: Bays with marinas. *Journal of Radioanalitical and Nuclear Chemistry*, 270: 75-85

5 - Http://dnr.wi.gov/org/aw/rr/technical/cbsqg_interim_final.pdf

6 - Http://www2.minvrom.nl/Docs/internationaal/annexS_I2000.pdf

ESTIMATION OF THE GREEK COASTAL ZONE CONTAMINATION BY THE MEANS OF BIOINDICATORS

Vassiliki - Angelique Catsiki [1]*, Caterina Tsangaris [1], Evangelia Strogyloudi [1] and Francois Galgani [2]
[1] HELLENIC CENTRE FOR MARINE RESEARCH - cats@ath.hcmr.gr
[2] IFREMER

Abstract

The contamination of the Greek coastal zone was investigated in the framework of the Programme MYTIMED (INTERREG IIIb - MEDOCC). Caged mussels were transplanted in 38 sites along the Greek coastline. Measured contaminant levels in caged mussels were similar to those from previous studies and achieved to differenciate contaminated and unpolluted areas. Mussels from Saronikos and other gulfs were the more contaminated, followed by Ionian sea, North. Central and Eastern Aegean areas had intermediate concentrations and South Aegean and Libyan areas had the lowest. Biomarker's and metal's statistical analysis showed similar results with small exceptions. However biomarker's and bioaccumulation's results are complementary and offer different information for the environmental status of a site.

Keywords: Bio-Accumulation, Metals, Bio-Indicators, Monitoring

Introduction

The contamination of the Greek coastal zone was investigated in the framework of the Programme MYTIMED (INTERREG IIIb - MEDOCC). The Programme aimed evaluating the chemical quality of Eastern Mediterranean exploiting the active biomonitoring qualities of mussels [1].

Materials and methods

Caged mussels originated from an aquaculture in Saronikos gulf, were transplanted in 38 sites along the Greek coastline in depths ranging from 20 to 30 m and occasionaly deeper for a period of 3 months. Metals (Cu, Ni, Mn, Zn and Fe) and biomarkers (Metallotheioneins, Acetylholynesterase, Catalase and Glutathione-S-Transferase) were determined in 4-5 pooled replicates from each station. The standardisation of metallic results was based on the condition index, while biomarker results were not standardised.

Results and discussion

The recovery of cages reached 92%: only 3 cages couldn't be collected. Mortality was less than 20% that is similar to previous studies [2]. Concentration of metals expressed in µg/g dry weight ranged from 2.33 to 5,81 for Cu, 1.61 to 7,56 for Ni, 38 to 233 for Zn, 1,76 to 11,0 fro Mn and 38 to 182 for Fe. Metallothioneins ranged between 94 and 225 µg/g tissue, Acetylholynesterase activities between 165 and 326 U/mg protein, Catalase activities between 0,7 and 3,59 U/mg protein and Glutathione-S-Transferase activities between 35.9 and 70.4 nmoles CDNB/mg protein.

Generally the measured contaminant levels in caged mussels were similar to those from previous studies in native populations [3], [4], [5] and achieved to describe differences between contaminated and unpolluted areas Fig 1.

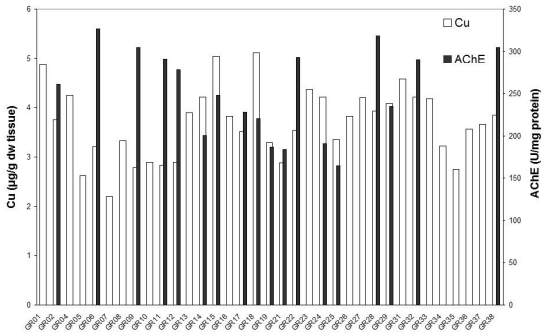


Fig. 1. Average values of Cu and AChE in transplanted mussel samples along Greece

In order to simplify the data we grouped the sampling stations in 8 groups as follows: Ionian sea, North Aegean, Central Aegean, South Aegean, east Aegean, Liberian Sea, Saronikos gulf, and Gulfs (Korinthiakos, Thermaikos, Evoikos and others gulfs). Analysis of variance between the 8 metal datasets showed similar results for all metals and revealed statistically significant differences among the 8 areas ($P<0.05$) Saronikos and the other gulfs being the more contaminated, followed by Ionian sea stations. North, Central and Eastern Aegean areas had intermediate concentrations while South Aegean and Libyan areas had the lowest. Biomarker's statistical analysis showed also similar results for all of them. Although the observed differences among the areas were not statistically significant, the obtained pattern was similar with that of metals, with the exception of Libyan stations witch showed stress. The above phenomenon could possibly be attributed to other kind of stress than contaminants, since the used species reached there its geographical limits.

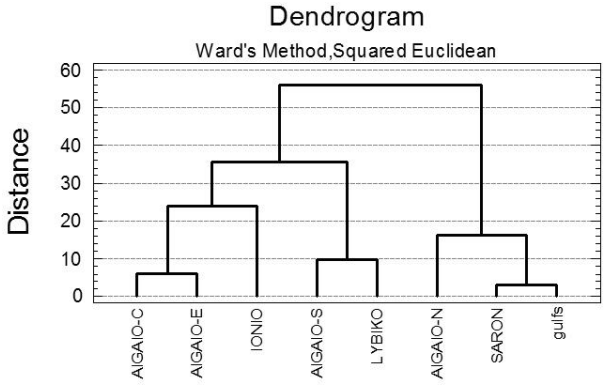


Fig. 2. Cluster of mean values of measured parameters per main geographical Greek area

The clustering of data (Fig 2) -containing mean values of each parameter per geographic area was in accordance with ANOVA analysis foundlings. However we have to note that biomarker's and bioaccumulation's results are complementary and offer different information for the environmental status of a site.

References

1 - Fabris J.G., Richardson B.J., O'Sullivan J.E., Brown F.C., 1994. Estimation of cadmium, lead and mercury concentration in estuarine waters using the Mytilus edulis planulatus L. *Environ. Toxicol. Water Qual.* 9, 183-192.

2 - Andral B., Stanisiere J-Y., Sauzade D., Damier E., Thebault H., Galgani F., Boissery P., 2004. Monitoring chemical contamination levels in the Mediterrannean based on the use of mussel caging. *Mar. Poll. Bull* 49: 704-712.

3 - Catsiki V.A. & Florou H. 2006. "Study on the behavior of the heavy metals Cu, Cr, Ni, Zn, Fe, Mn and 137Cs in an estuarine ecosystem using Mytilus galloprovincialis as a bioindicator species: the case of Thermaikos Gulf, Greece". *J. Environ. Radioactivity* 86 (2006): 31-44.

4 - Catsiki V.A. 2005., "Heavy metals in biota". In: SoHelME. 2005. State of the Hellenic Marine Environment. E. Papathanassiou & A. Zenetos (eds), *HCMR Publ*., p:157-164.

5 - C. Tsangaris, E. Strogyloudi and E. Papathanassiou., 2005. Measurement of biochemical markers of pollution in mussels Mytilus galloprovincialis from coastal areas of the Saronicos Gulf (Greece). *Mediterranean Marine Science*, 5/1:175-186.

ALKYLBENZENE ORIGIN IN RECENT SEDIMENTS FROM THE HYPERSALINE ENVIRONMENT OF MOKNINE SEBKHA. TUNISIA

Raja Chairi [1]*, Sylvie Derenne [2] and Claude Largeau [3]
[1] centre de recherches et de technologies des eaux. Technopole de Borj Cedria.Tunis.TUNISIE - chairi_ra@yahoo.fr
[2] Géochimie Organique et Minérale de l'Environnement.UMR CNRS 7618 BioEMCo.ENSCP.Paris. France
[3] ENSCP. Paris. France

Abstract
Organic matter sources in sediments from the north of Moknine hypersaline system were assessed using lipid biomarkers. Alkylbenzenes in the C18-C22 range, with an even carbon number predominance and a maximum at C19, occur in substantial abundance in most sediment samples. High molecular weight alkylbenzenes are only present in low concentration <1%. Total aromatic hydrocarbons are essentially composed of the isomers of C18, C19 and C20 alkylbenzenes. Cyclization and aromatization of linear alkanes was probably the pathway for the formation of most aromatic units upon organic matter diagenesis.
Keywords: Geochemistry, Bacteria, Coastal Systems, Evaporites, Organic Matter

Introduction
Alkylbezens moleculars have been detected in particulars geologicals systems under sulphate reduction conditions [1]. These systems are characterized by evaporitic deposits (carbonates and salt). In the present work we report the result of the study of aromatic fractions in the recent sediments of the hypersaline Moknine system. We identified the origin of aromatic fraction composed by the alkylbenzenes and the dynamic system in the recent.

Geological setting
The Moknine sebkha is an evaporator system from eastern zone of Tunisia and it belongs to group of the Sebkha with lozenge morphology near the Mediterranean sea. Periphery deposit is composed by sand and silty-sand (SM9) and medium zone and central part are composed by clay deposits and covered by Halite.

Methods
Sediments samples were collected from 3 sites (site 9, 10 and 12) of Moknine sebkha using PVC tube (75 mm of diameter). Samples were extracted with chloroform in a soxhlet extractor for 12h. Total extracts were fractionated by column chromatography on silica gel with different solvent sequentially. Aromatic hydrocarbons were obtained by eluting with a mixture of hexane and chloroform (2V/1V) and analysed by gas chromatography/mass spectrometry (GCMS) on Agilent Technologie 6890N connected with Agilent 5973 Network mass spectrometer (operated at 70eV, cycle time 2.24s, and range m/z: 35-600). Ratios of various biomarkers were calculated using peak heights. Compound were quantified by integration of appropriate mass chromatograms of m/z 91 and 105 (alkylbenzene, phytanylbenzene).

Results
Mass chromatography of m/z 91 reveals the presence of homologous series of n-alkylbenzene ranging in most samples from C18 to C22 in different profiles from the north of the Moknine sebkha. Sometimes peaks on C23 to C31 are detected in sediment. This distribution can be explained by the low biological diversity in hypersaline environments [2]. Moknine sebkha, is restrict evaporator environment where only cyanobacteria and algae developed [3].
All samples are dominated by linear alkylbenzenes which thought to be formed by cyclization and aromatization of precursor possessing linear carbon skeletons. They are substituted at different positions (1, 3, 4, 5, 6 and 7) and originate or are diagenetically transformed lipids. Generally, it's accepted that fatty acids derived from biological organisms are likely precursors of alkylbenzene in sediment via well-known sedimentary dehydration and cyclization reactions [4].
Two compound are identified C19 : 1-methyl-4-dodecylbenzene and 1-ethylundecylbezene or 3phenyltridecane and C20 : 1-methyl-4-tridecylbenzene components, characterized by a base peak at 105 and 119 and corresponding molecular ions at m/z 260 and 274. The highest concentrations of isoprenoid benzenes occur in clay sediments of the centre which is associated with high concentration of halite. In this context halophilic archaebacteria have been suggested previously as a source for sedimentary phytanylbenzene [5]. In the Moknine sebkha these component derived from algae or cyanobacteria. In fact, the similar structure of the phytanyl benzenes and natural quinones when the isoprenyl group position is compared with the methyl groups in the aromatic ring [1].The presence of phenylbenzene in the Moknine system could be related to highly reducing palaeoenvironments.

Conclusion
Organic matter constitutes a minor but important fraction of hypersaline Moknine system sediment. Sources of organic matter include primary production within the system; input of terrestrial material and products connected to microbial activity in water and sediment. The distributions of the alkylbenzene compared to the n-alkanes distribution show that the carbon number distributions of these alkylbenzene compounds resembled those of the n-alkanes found in the same sediment with the high odd carbon preference between nC17-nC31. This indicates that the alkylbenzenes may have the same fatty acid precursors as the n-alkanes. The alkybenzene could have been formed by direct cyclization and aromatization, while the n-alkanes could have been formed by decarboxylation of the straight chain fatty acids.

References
1 - Evans, R., and Kirkland, D. W., 1988. Evaporitic environments as a source of petroleum. In Evaporites and Hydrocarbons. In Schreiber B.C. (ed), Am. Chem. Soc., Washington, pp.613-632.
2 - Chairi, R., 2005. Etude du remplissage sédimentaire d'un système hypersalin de la Tunisie orientale au cours du quaternaire récent: la sebkha de Moknine. Quaternaire 16, 107-117.
3 - Ellis, L., Fisher S.J., Singh, R. K., Alexander, R., Kagi, R.I., 1999. Identification of alkenylbezenes in pyrolyzates using GC-MS and GC-FTIR techniques: evidence for kerogen aromatic moieties with various binding sites. *Org. Geochem.* 30, 651-665.
4 - Sinninghe Damest, J. S., Keely B. J., Betts S. E., Baas M., Maxwell J.R. and De Leeuw, 1993 : Variations in abundances and distributions of isoprenoid chromans and long-chain alkylbenzenes insediments of the Mulhouse basin : a molecular sedimentary record of palaeosalinity. *Org.geochem.*, 20, 8, 1201-1215.

EVALUATION DES TENEURS EN CADMIUM, PLOMB, MERCURE ET EN BENZO(A)PYRÈNE DANS LA CHAIR DE *RUDITAPES DECUSSATUS* DU LITTORAL TUNISIEN

L. Chouba [1]*, N. Mzoughi [1], C. Tissaoui [1], Z. Souli [1] and R. M'rabet [1]
[1] INSTM, Port de Pêche 2060 La Goulette, Tunis – Tunisie - lassaad.chouba@instm.rnrt.tn

Abstract
La palourde reste l'espèce la plus estimée en Tunisie, elle est répartie le long du littoral tunisien avec une concentration plus importante au Nord et au Sud. L'étude de la composition en métaux traces et en benzo(a)pyrène (BaP) de cette espèce provenant des différentes régions de la Tunisie a été réalisée dans ce travail. Les résultats montrent que la palourde des zones Sud présente des concentrations plus importantes en Cd, en Pb et en BaP que les zones Nord. Pour le Hg, la teneur trouvée varie d'une zone à l'autre, le maximum est enregistré au niveau de Tunis.
Keywords: Metals, Bio-Accumulation, Bivalves

Matériel et Méthodes
Les échantillons *R. decussatus* prélevés sont mesurés et pesés. Ensuite, la totalité de la chair est récupérée, homogénéisée, lyophilisée, broyée et tamisée. La minéralisation est effectuée par micro-onde (Mellistone). Les dosages des métaux Cd et Pb sont réalisés par Spectrophotométrie d'Absorption Atomique (SAA type Varian 220Z) à four graphite, celui du Hg par la SAA en vapeur froide. L'assurance et le contrôle qualité sont assurés par l'utilisation de matériau de référence certifié (Nist 2976). Les analyses de benzo(a)pyrenne selon la méthode de l'UNEP [1]. Une analyse statistique moyennant les Analyses en Composantes Principales (ACP) [2] a été utilisée pour comparer les régions.

Résultats et Discussion
Les analyses ont été effectuées sur 4 lots de 25 spécimens provenant de cinq zones, Sfax (S), Gabès (G), Médenine (M), Bizerte (B) et Tunis (T) (Figure 1) durant les années 2007 et 2008. Les dosages des éléments chimiques ont été réalisés par SAA et par GC/FID.

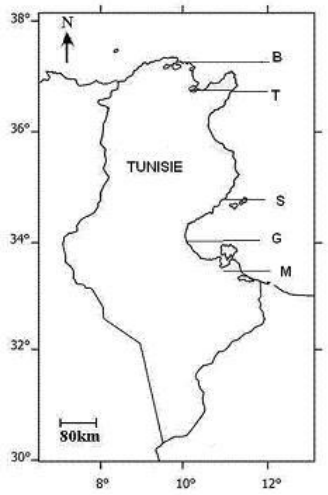


Fig. 1. Zone des prélèvements des échantillons de la palourde (*R. decussatus*) le long des côtes tunisiennes (B:Bizerte,T: Tunis,S: Sfax, G:Gabes, M : Médenine)

Les moyennes et les écarts types des teneurs en métaux traces et en benzo(a) pyrène dans la masse molle de la palourde provenant des différentes zones sont résumés dans le tableau 1. Les résultats montrent une variation nette entre les sites étudiés, sauf pour le BaP qui est du même ordre de grandeur dans toutes les zones.
Les teneurs en métaux traces montrent que la palourde des zones Sud de la Tunisie S, G et M présente des concentrations plus importantes en cadmium que les zones Nord B et T. En effet, elles sont dues aux rejets anthropiques et industriels dans cette région [3]. Pour le Hg et le Pb, les doses trouvées varient d'une zone à l'autre. Le maximum est enregistré au niveau de la zone de Tunis (T), caractérisée par la présence de stations thermiques. Les concentrations en BaP considérées comme indicateur de pollution par les HAP [4] ne présentent pas une différence entre les zones. Cette étude montre que la bioaccumulation des métaux traces dans la palourde varie en fonction des zones. Les faibles teneurs enregistrées dans certaines zones dénotent la faible contamination du milieu par les éléments en traces. En effet, les travaux d'Ennouri [5] et de Sfriso [6] montrent que la bioaccumulation dans les bivalves dépend de la disponibilité des métaux dans le milieu qui est lui-même tributaire des rejets anthropiques et industriels déversés. L'analyse statistique nous a permis d'identifier trois groupes, le premier constitué par Sfax et Médenine présentant la contamination la plus forte, le second formé par Tunis indiquant une contamination par le Pb et enfin le dernier groupe renfermant Bizerte où les éléments dosés sont faibles par rapport aux autres zones. Donc, la qualité de la palourde dépend étroitement de la zone où elle vit et par conséquent du type de nourriture et de l'état du milieu environnant. On peut conclure que ce travail nous permet d'avoir un aperçu de la qualité chimique de l'ensemble du milieu étudié. Toutefois, il faut noter que le degré de contamination par les micropolluants dosés dans la palourde tunisienne reste largement inférieur aux normes usuelles (Tableau 1).

Tab. 1. Teneurs moyennes en métaux traces et en benzo(a)pyrène dans la chair de la palourde des côtes tunisiennes (± écart type ; Poids Frais (PF))

Zones	Cd µgg^{-1} PF	Pb µgg^{-1} PF	Hg µgg^{-1} PF	BaP µgKg^{-1} PF
B	0,042±0,002	0,557±0,105	0,019±0,001	2,212±0,811
T	0,064±0,003	0,620±0,071	0,049±0,005	2,103±0,721
S	0,310±0,053	0,267±0,035	0,052±0,001	1,911±0,101
G	0,249±0,031	0,177±0,034	0,020±0,002	-
M	0,247±0,036	0,502±0,062	0,041±0,004	2,932±0,813
Normes	1	1,5	0,5	10

References
1 - UNEP/FAO/IAEA/IOC,1996. Détermination des composés organochlorés et des hydrocarbures pétroliers dans l'environnement. Reference Methods for Marine Pollution Studies N° 71 : 1-29.
2 - Lebart Ludovic, Morineau Alain, Piron Marie., 1995. Statistique exploratoire multidimensionnelle, Edit. Dunod Paris, 1995.
3 - Chouba L. Amara H.and El Abed, A., 2001. Heavy metals (Cd, Pb, Hg) in marine organisms from north Tunisian Coast. *Proceeding of the Fifth International Conference on the Mediterranean Coastal Environment, MEDCOAST*, Vol.1-3 : 523p.
4 - Mzoughi N. and Chouba L., 2005. Etude des micropolluants organiques et inorganiques dans les sédiments et les organismes marins du large du Golfe de Gabès, *Physical and Chemical News* N°22 : 125-131.
5 - Ennouri R.; Chouba L.; Magni P. and Kraiem M.M., 2009. Spatial distribution of trace metals (Cd, Pb, Hg, Cu, Zn, Fe and Mn) and oligo-elements (Mg, Ca, Na and K) in surface sediments of the Gulf of Tunis (Northern Tunisia). *Environ. Monit. Assess.* DOI 10.1007/s 10661-009-0829-5.
6 - Sfriso A.; Argese E.; Bettiol C. and Facca C., 2008. *Tapes philippinarum* seed exposure to metals in polluted areas of the Venice lagoon. *Estuarine Coastal and Shelf Service*. Vol. 79 : 581-590.

MERCURY BIOACCUMULATION IN THE EUROPEAN HAKE (MERLUCCIUS MERLUCCIUS) FROM THE GULF OF LIONS AND THE BAY OF BISCAY

D. Cossa [1]*, M. Harmelin-Vivien [2], C. Mellon-Duval [1], V. Loizeau [1] and S. Crochet [1]
[1] IFREMER - dcossa@ifremer.fr
[2] Université de la Méditerranée

Abstract
Total (HgT) and methylmercury (MeHg) concentrations were measured in the muscle tissues of European hakes (*Merluccius merluccius*) from the Gulf of Lions (Northwestern Mediterranean) and the Bay of Biscay (Northeastern Atlantic). Similar chemical measurements have been performed on plankton samples and fish preys sampled in the same areas. Relationships between HgT and MeHg concentrations and the size, sex, δ15N (indicator of food web structure), growth rate and habitat of the fish were examined. Difference in growth rate between the two environments and change in feeding habits when the fish is entering adulhood seem to be the major factors governing the mercury bioaccumulation.
Keywords: Fishes, Mercury

Introduction
Mercury biomagnification in aquatic food webs is well established (Luoma and Rainbow, 2008). This process results from high efficiency of uptake and slow excretion of methylmercury (MeHg) in biota. In this context, differences in the Hg bioaccumulation in the same fish species caught from different environments can be due to factors such as mercury bioavailability, fish growth rate and specific food web structure of the fish habitat. Here, we document the bioaccumulation of HgT and MeHg in the muscle of the hake (Merluccius merluccius) from the Gulf of Lions (NW Mediterranean) and the Bay of Biscay (NE Atlantic); the aim of this study was to improve our understanding of mercury bioaccumulation pathways in marine fish.

Studied sites
The samples were collected along the shelves and continental slopes of the Bay of Biscay (BB) and Gulf of Lions (GL) in 2002 and between 2004 and 2006 respectively.

Methylmercury in the water column
The vertical distributions of MeHg in the water column near the fish sampling stations exhibit similar patterns in the two studied areas: concentrations were low in the photic zone and they increased downward within the organic matter mineralization zone; this is consistent with recent observations made in the open waters of the Mediterranean Sea (Cossa et al., 2009). L

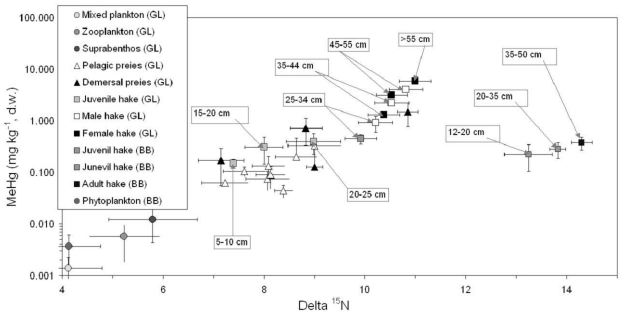


Fig. 1. Methylmercury *versus* delta 15N in the muscle of hakes and their preys from the Atlantic and Mediterranean

Effect of trophic position
The bioaccumulation and biomagnification of MeHg in the hake muscle, and in plankton, suprabenthos and other components of the food web are illustrated on figure 1 using δ15N as a proxy of the trophic level. The increase of the MeHg concentration with the trophic level agrees with the current paradigms (Hoffman et al., 2003). However, we observed two special features: (i) a shift toward higher δ15N for hakes from BB compared to similar size individuals from the GL, and (ii) higher MeHg concentrations in the muscle of the Mediterranean hake (GL), in spite of their lower δ15N. In fact, the shift for high δ15N concerns not only the Atlantic hake but also its whole food web since similar δ15N (4.1 %0) are found for plankton mixture from GL and phytoplankton from BB. It is also noteworthy that the slope of the relationship MeHg vs δ15N is steepest for adult hake from GL. This last observation is probably related to the changes in feeding habits when the fish is entering adulthood, i.e., 25 cm for GL hake and 40 cm for BB. These changes go with the differences in the growth rates of the hake between the two studied environments (Fig. 2).

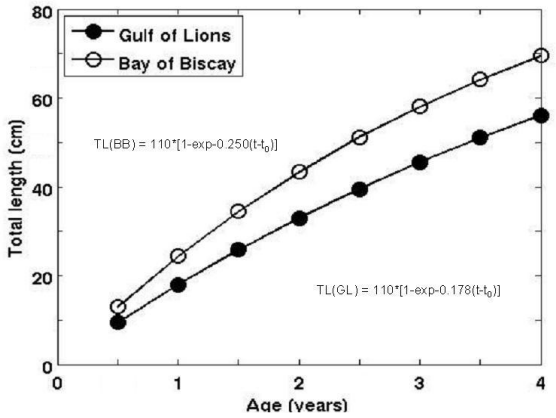


Fig. 2. Total length *versus* age of hakes from the Atlantic and Mediterranean

Effect of fish growth rates
The higher growth rate of hakes from the Bay of Biscay relative to those of the Gulf of Lions (Mellon-Duval, in press) may produce a biological dilution of the MeHg mercury absorbed by the fish and accumulated in the muscle tissue. Individuals enter adulhood when they reach 2 years in both areas.

References
1 - Cossa, D., B. Averty and N. Pirrone. 2009. The origin of methylmercury in the open Mediterranean water column. *Limnol. Oceanogr*., 54 (3) : 837–844.
2 - Hoffman, D.J., B.A. Rattner, J.A. Burton Jr. and J. Cairns Jr. 2003. *Handbook of Ecotoxicology*. 2nd ed., 1290 p. Lewis Publisher.
3 - Luoma, S.N. and P.S. Rainbow., 2008. Metal Contamination in Aquatic Environments. Cambridge University Press. 573p.
4 - Mellon-Duval, C. et al. (in press). Growth of the European hake (*Merluccius merluccius* L., 1758) in the Gulf of Lions based on conventional tagging. *ICES Journal of Marine Science*.

TRACE METALS AND DISSOLVED ORGANIC CARBON IN WATER COLUMN OF AN ANCHIALINE OBJECT IN MLJET NATIONAL PARK - CROATIA

Vlado Cuculic [1]*, Neven Cukrov [1], Željko Kwokal [1] and Cedric Garnier [2]

[1] Rudjer Boškovic Institute, Division for Marine and Environmental Research, Bijenicka 54, 10000 Zagreb, CROATIA - cuculic@irb.hr

[2] Laboratoire PROTEE, Université du Sud Toulon Var, BP 20132, 83957 La Garde, FRANCE

Abstract

Distribution of Cd, Pb, Cu, Zn and dissolved organic carbon (DOC) in water column of Bjejajka anchialine cave were studied seasonally (wet and dry periods). Metal amounts in water column were significantly higher compared to those found in seawater samples taken in near vicinity (100 m). Unusually elevated concentrations of cadmium (up to 300 ng L^{-1}) were found in water column of Bjejajka cave, which are two orders of magnitude higher than in nearby surface seawater (~ 7 ng L^{-1}). DOC amount in cave water column (up to 10.5 mg C L^{-1}) was enhanced comparing to open seawater (up to 3 mg C L^{-1}), and diminished below halocline. Elevated concentrations of trace metals and DOC in Bjejajka anchialine cave were of natural origin caused by biogeochemical processes.

Keywords: Metals, Organic Matter, Adriatic Sea

Experimental

Bjejajka anchialine cave in the remote Mljet National Park is connected hydraulically with Adriatic seawater. Tide inside the cave follows outer surface seawater level, but replenishment of the water is restricted by the karst rock. The water in the cave has a long residence time compared to a fully-flushing cave. This anchialine environment reveals a number of characteristics, such as well-developed halocline and hypoxia. Water samples for Cu, Cd, Pb, Zn and DOC determination were collected during 2009 by speleo scuba-diver. Metal measurements were performed by differential pulse anodic stripping voltammetry (DPASV), while DOC was obtained by high temperature catalytic oxidation using a non-dispersive infrared detector. Trace metals concentrations are presented as dissolved and total fractions. Total metal concentrations were measured in acidified (pH < 2), unfiltered and UV irradiated samples, while dissolved metal and DOC concentrations were obtained from filtered (0.45 µm) samples. Additionally, temperature, salinity, pH and dissolved oxygen concentration were determined directly in water column of anchialine cave. Salinity increased with depth in the range from 3 ‰ at the surface to 38 ‰ in bottom water layer, showing water column stratification.

Results and discussion

Metals concentrations throughout entire water column of Bjejajka anchialine cave were significantly higher compared to metals amount found in seawater samples taken in near vicinity (about 100 m). Total metal concentrations in cave's water column were found as follows: Pb from 0.05 to 1.4 µg L^{-1}, Cu from 0.73 to 4.82 µg L^{-1} and Zn from 0.74 to 3.05 µg L^{-1}. Moreover, cadmium concentrations in water column of Bjejajka cave were greatly elevated compared to Cd amounts found in surface seawater. In January 2009, substantial concentrations of total Cd were found in bottom water layer (300 ng L^{-1}) and in surface layer 45 ng L^{-1} in Bjejajka cave water column. However, in surface seawater samples collected in the vicinity of the Bjejajka cave, quite low total concentrations were measured, i.e. 7 ng L^{-1} Cd, 30 ng L^{-1} Pb, 200 ng L^{-1} Cu and 200 ng L^{-1} Zn. Bjejajka cave was developed in Mesozoic dolomites with limestone lenses. It has been demonstrated that dolomitic rocks can contain elevated concentrations of Zn, Pb, and Cd [1]. Mineral leaching of such lithologies is responsible for the increased Pb, Zn and particularly Cd amounts in waters of Mljet NP [2]. Cd concentrations in anchialine cave water column increase linearly with salinity (Fig. 1A). It implies mineral leaching of dolomitic rocks by seawater entering the cave, hence carrying Cd into the bottom layer of cave's water column. Also, cave's water receives considerable metal amounts by wet deposition and soil weathering. Hence, Cd, Pb and Zn contents have been enhanced in cave's upper water layers during and after rainy periods. Furthermore, a colony of bats inhabits Bjejajka cave. Cadmium concentration in guano of these flying mammals was found to be 1.8 mg kg^{-1} wet weight. Since the Cd concentration in bat guano has not been reported so far, we compared it with amounts usually reported in Eastern Adriatic Sea coastal sediments that contain significantly lower Cd content (< 0.8 mg kg^{-1} wet weight) [3]. Apparently, natural process of bat guano leaching also was the source of cadmium elevated concentrations in water column and sediment of Bjejajka cave.

DOC content in cave's water column was enhanced (up to 10.5 mg C L^{-1}) compared to seawater (up to 3 mg C L^{-1}) and generally decreases with depth and linearly with increasing salinity (Fig. 1B). It suggests that terrestrial input by soil weathering and bat guano leaching would be the source of elevated DOC concentrations.

In studied area, without considerable anthropogenic influence, natural processes of mineral leaching, soil weathering and input of terrestrial natural material were likely responsible for significantly elevated trace metals and DOC concentrations in water column of an anchialine cave.

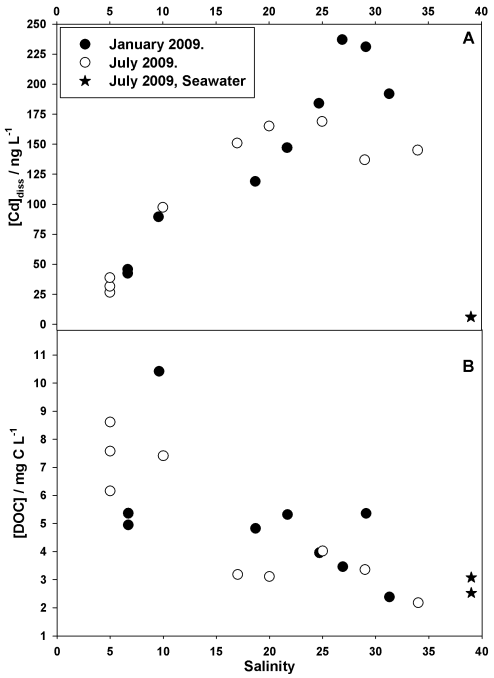


Fig. 1. Seasonal dissolved Cd (A) and dissolved organic carbon (B) concentrations vs. salinity (ppt) in Bjejajka cave water column.

References

1 - McBride, M.B., Barrett, K.A. and Martinez, C.E., 2005. Zinc and cadmium distribution and leaching in a metalliferous peat. *Water Air Soil Pollut.*, 171: 67-80.

2 - Cuculic, V., Cukrov, N., Kwokal, Ž. and Mlakar, M., 2009. Natural and anthropogenic sources of Hg, Cd, Pb, Cu and Zn in seawater and sediment of Mljet National Park, Croatia. *Estuarine Coastal Shelf Sci.*, 81: 311-320.

3 - Martincic, D., Kwokal, Ž., Stoeppler, M. and Branica, M., 1989. Trace Metals in Sediments from the Adriatic Sea. *Sci. Tot. Environ.*, 84: 135-147.

TRACE METALS IN BIVALVES' SOFT TISSUE FROM MLJET NATIONAL PARK AQUATORIUM, CROATIA

Vlado Cuculic [1], Neven Cukrov [1], Željko Kwokal [1] and Marina Mlakar [1]*

[1] Rudjer Boškovic Institute, Division for Marine and Environmental Research, Bijenicka 54, 10 000 Zagreb, CROATIA - mlakar@irb.hr

Abstract

Preliminary study of bivalves' soft tissue exposure to trace metals (Cd, Pb, Cu and Zn) from water column in the Mljet NP, was done. Elevated trace metal concentrations in water column and bivalves were observed in semi-enclosed saline lakes. Determined concentrations were most likely from the natural source, taking into account hydrogeological characteristics of the investigated area.

Keywords: Adriatic Sea, Metals, Bivalves

INTRODUCTION

Mljet NP is part of the Mljet island in Croatian Southern Adriatic with two connected saline lakes as its main water body (Fig. 1). Veliko Jezero (VJ) and Malo Jezero (MJ) lakes were developed in Mesozoic limestones and dolomites, which are semi-enclosed and connected to the open sea by narrow channel. It is very important to highlight that dolomitic rocks can contain elevated concentrations of Zn, Pb and especially Cd [1]. For metals determination composite soft tissue samples of nearly equal bivalves length were prepared, as accumulation of metals is connected with biotic and abiotic factors governed by their size and age [2]. Metals concentrations were measured by differential pulse anodic stripping voltammetry (DPASV).

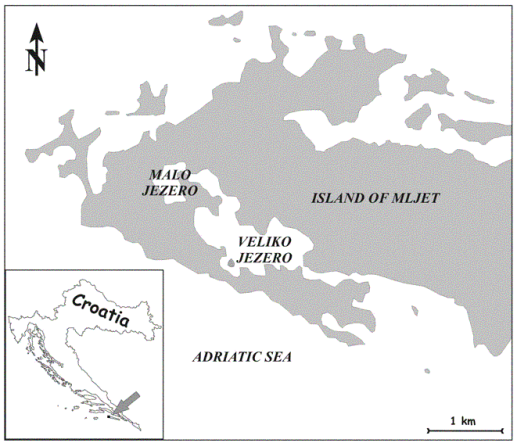


Fig. 1. Mljet National Park map

RESULTS AND DISCUSSION

Bivalves' samples were taken from Malo jezero lake, Veliko jezero lake and open sea coastal area. Bivalves investigated were: *Arca noae, Mytilus galloprovincialis, Modiolus barbatus and Ostrea edulis*. There are major differences in the uptake rate of dissolved metals among different species of bivalves [3]. E.g. scallops and oysters have the highest uptake rate constants for different metals as result of their high pumping rates. Within Malo Jezero lake underwater karstic spring (freshwater efflux by dolomite rocks leaching and soil weathering, showed high metal concentrations) is located. Karstic spring input raised metal concentrations in waters of the National park water body [4]. Therefore, metal concentrations (Zn, Pb and especially Cd) in the water column and in bivalves, were over expected values. Most interesting were Cd concentrations in tissues of *Modiolus barbatus and Ostrea edulis* that were over 1 mg/kg wet weight in all investigated Mljet water bodies (MJ and VJ) (Table 1). Considering the National bylaw on toxins, metals, metaloids and other harmfull substances in food, maximum allowed values of Cd in the tissue of shellfish is 1 mg/kg, while in *Ostrea edulis* 1.68±0.09 mg/kg in MJ and 0.37±0.03 mg/kg in VJ, were found. In *Mytilus gal.* and *Arca noae* were below 1 mg/kg due to different metabolism of these bivalves [3]. Cd dissolved concentrations in the Mljet NP lakes were enhanced due to input of its considerable amounts through the karstic spring and dissolved cadmium concentrations in Mljet NP water body were: MJ (near karstic spring) 18.7±1.4 ng L^{-1}, in VJ 12.0±0.6 ng L^{-1} and in the open Adriatic sea 6.4±0.9 ng L^{-1}. All metal concentrations in bivalves were given as mass in wet weight.

Zn, Pb and Cu concentrations in composite bivalve soft tissue samples are shown in Table 1. As an example, metals concentrationsin *Ostrea edulis* were found to be: Zn 1322±39 mg/kg in MJ and 251.3±8.8 mg/kg in VJ; Cu 34±1.26 mg/kg in MJ and 26.41±3.01 mg/kg in VJ; Pb 0.22±0.04 mg/kg in MJ and 0.10±0.01 mg/kg in VJ (all mass concentrations are in wet weight). In the water column of all Mljet NP water bodies concentrations of these metals were enhanced, especially after heavy rainfalls. The lack of anthropogenic influence on the lakes metal concentrations, suggested natural sourcing of these elements into the lakes. It should be taken into account that Cd is present in the water column mostly in dissolved form, appropriate for accumulation in bivalves. Zinc and copper were partly adsorbed onto particles but still in significant amount as dissolved and available for accumulation by bivalves. Pb is adsorbed the most onto particles and its concentration in bivalves' soft tissue was lowest.

This study showed, unequivocally, the suitability of bivalves as metal biomonitors, as metal concentrations are not necessarily elevated due to anthropogenic activities. Unexpectedly high metal concentrations (cadmium the most) in the water column and bivalves originated from dolomite rocks and was brought to waters by leaching and soil weathering during rainfalls. Enhanced cadmium level in bivalves over allowed concentrations regulated by national bylaw on harmful substances in food, was determined to originate from natural source, dolomite rocks leaching, in the first place.

Tab. 1. Metal concentrations in bivalves soft tissues (expressed in ug/g wet weight) sampled in aquatorium of National Park Mljet

	Bivalves	Zn	Cd	Pb	Cu
Open sea	*Arca noae*	18.3±1.4	0.31±0.00	0.14±0.02	0.57±0.04
	Mytilus gal.	28.8±2.1	0.63±0.05	0.24±0.03	1.32±0.06
Veliko jezero	*Arca noae*	34.2±0.5	0.32±0.01	0.12±0.01	2.7±0.2
	Mytilus gal.	25.7±2.5	0.26±0.04	0.15±0.02	0.94±0.06
	Ostrea edulis	251.3±8.8	0.37±0.03	0.10±0.01	26.41±3.01
Malo jezero	*Arca noae*	27.3±2.0	0.58±0.02	0.14±0.01	1.18±0.12
	Mytilus gal.	29.8±1.4	0.56±0.03	0.17±0.01	0.93±0.07
	Modiolus barbatus	70.5±6.4	2.73±0.30	0.65±0.05	3.12±0.24
	Ostrea edulis	1322±39	1.68±0.09	0.22±0.04	34.57±1.26

References

1 - McBride, M. B., Barrett, K.A. and Martinez, C.E., 2005. Zinc and cadmium distribution and leaching in a metalliferous peat. *Water Air Soil Pollut.*, 171: 67-80.

2 - Martincic, D., Kwokal, Ž. and Branica, M., 1987. Trace metals in selected organisms from the Adriatic sea. *Mar. Chem.*, 22: 207-220

3 - Wang, W.-X., 2001. Comparison of metal uptake rate and absorption efficiency in marine bivalves. *Environ. Toxicol. Chem.*, 20: 1367-1373.

4 - Cuculic, V., Cukrov, N., Kwokal, Ž. and Mlakar, M., 2009. Natural and anthropogenic sources of Hg, Cd, Pb, Cu and Zn in seawater and sediment of Mljet National Park, Croatia. *Estuarine Coastal Shelf Sci.*, 81: 311-320.

A PRELIMINARY STUDY OF TRACE METALS AND PHYSICO-CHEMICAL PARAMETERS IN WATER COLUMN OF ANCHIALINE CAVE ORLJAK, CROATIA

N. Cukrov [1]*, A. Blataric [1], V. Cuculic [1], C. Garnier [2], B. Jalžic [3] and D. Omanovic [1]
[1] Rudjer Boskovic Institute, Division For Marine And Environmental Research, Bijenicka 54, 10000 Zagreb, CROATIA - ncukrov@irb.hr
[2] Laboratorie PROTEE, Université Du Sud Toulon Var, BP 20132, 83957 La Garde, FRANCE
[3] Croatian Biospeleological Society, Demetrova 1, 10000 Zagreb, CROATIA

Abstract
A preliminary study of distribution of total trace metal concentrations (Cd, Pb, Cu and Zn) and physico-chemical parameters (water temperature, pH, dissolved oxygen (DO), dissolved organic carbon (DOC) redox and salinity) in water column of anchialine cave Orljak in the well stratified Krka River estuary (Croatia) has been performed. Metal amounts and physico-chemical parameters in cave water column were compared with related column in Krka River estuary.
Keywords: Estuaries, Metals, Adriatic Sea, Organic Matter

Study area & methodology
Recently anchialine objects as a very unusual aquatic environments became target of interdisciplinary research [1,2]. The Orljak cave is unique anchialine cave at Eastern Adriatic coast because of its connection with brackish water. Anchialine cave Orljak is located in Cretaceous limestone with macro fossils 50 m from coast in lower part of the Krka River estuary. Cave is 23 m deep and 90 m long with two water bodies (2 and 7 m) probably well hydraulically connected with estuary water (tides are notable).

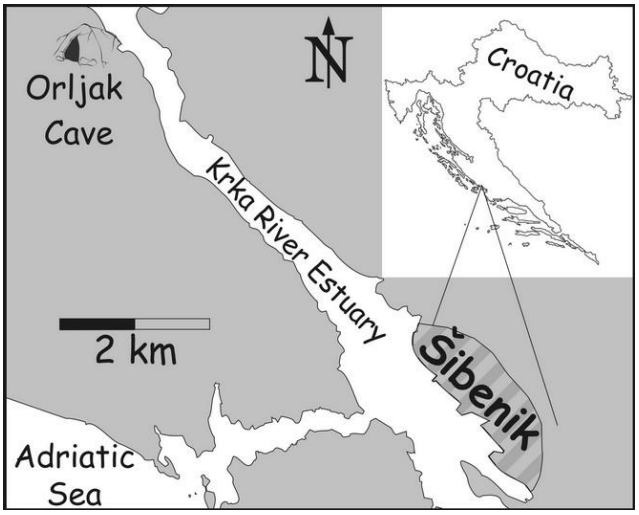


Fig. 1. Location of anchialine cave Orljak.

Physico-chemical parameters (water temperature, pH, dissolved oxygen, redox potential and salinity) were measured in situ by Hydrolab MiniSonde 4a equipped with the following sensor: pressure (depth), T, conductivity/salinity, pH (with Ag/AgCl/KCl sat as reference), Eh (Pt xire with the same ref as pH), O2 (by amperometric measurement). Samples for DOC and trace metal analyses (Cd, Pb, Cu and Zn) were taken by scuba divers, respecting a principle of a ‘‘clean sampling technique” in summer 2009. Concentrations of DOC were determined using a TOC-V analyser (Shimadzu), calibrated using sodium hydrogenophtalate standard solutions, with an accuracy of 0.8 μMC. Total trace metal concentrations were measured in unfiltered, acidified (pH < 2) and UV irradiated water samples (24 h, 150W mercury lamp, Hanau, Germany). Determination of Cu, Cd, Pb and Zn concentration were performed by differential pulse anodic stripping voltammetry (DPASV) using static mercury electrode (663 VA STAND, Metrohm, Switzerland) connected to μAUTOLAB potentiostat (EcoChemie, Utrecht, The Netherlands).

Results and discussion
Values of physico-chemical parameters (water temperature, pH, dissolved oxygen (DO), from anchialine cave Orljak and the Krka River estuary are graphically presented in Figure 1 A and Figure 2 B, respectively. Total metal concentrations and dissolved organic carbon (DOC) from cave and estuary are graphically presented in Figure 1 C and Figure 1 D, respectively. Quite low and constant DOC concentrations along the cave water column profile reflect absence of autochthones DOC productivity by phytoplankton, as well as neglected anthropogenic influence (Fig. 2A). Total metal concentrations of zinc, cadmium and lead in anchialine cave’s water were higher comparing to concentrations in estuary waters, while total copper concentrations were higher in estuary waters due intensive boat traffic [3].

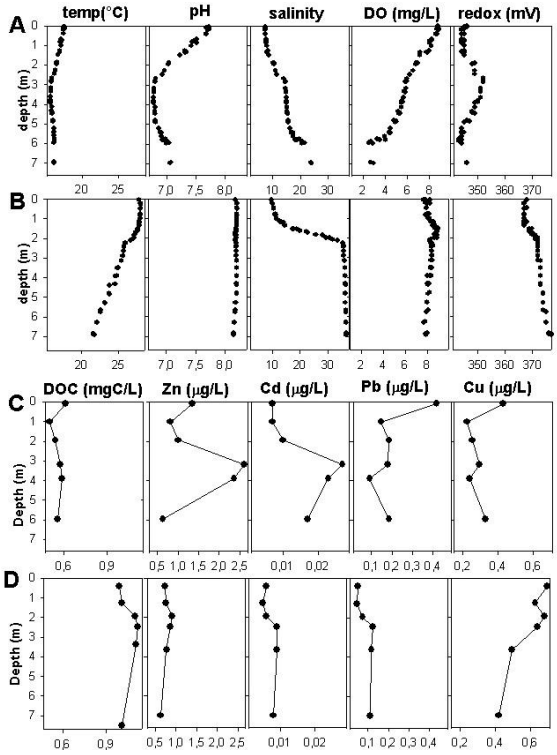


Fig. 2. Vertical profiles of temperature, pH, salinity, redox, dissolved oxygen (DO), dissolved organic carbon (DOC) and total concentrations of Zn, Cd, Pb and Cu in Orljak Cave and Krka River estuary.

References
1 - Žic, V., Truesdale, V.W. and Cukrov, N. 2008. The distribution of iodide and iodate in anchialine cave-waters – evidence for sustained localised oxidation of iodide to iodate in marine water. *Mar. Chem*., 3-4: 168-178.
2 - Kršinic, F. 2008. Description of Speleophria mestrovi sp. nov., new copepod (Misophrioida) from an anchialine cave in the Adriatic Sea. *Mar. Biol. Res*., 4; 304-312.
3 - Omanovic, D., Kwokal, Ž., Goodwin, A., Lawrence, A., Banks, C.E., Compton, R.G. and Komorsky-Lovric, Š., 2006. Trace metal detection in Šibenik bay, Croatia: Cadmium, lead and copper with anodic stripping voltammetry and manganese via sonoelectrochemistry. A case Study. J. *Iranian Chem. Soc*., 3: 128–139.

HEAVY METAL LEVELS IN MACROALGAE FROM SINOP IN THE BLACK SEA

S. T. Çulha [1], F. Koçbas [2]*, A. Gündogdu [3], S. Topçuoglu [4] and M. Çulha [5]
[1] Celal Bayar University, Faculty of Arts and Sciences, Department of Biology - fatma.1970@hotmail.com
[2] Department of Aquaculture, Faculty of Fisheries and Aquaculture, University of Sinop, 57000 Sinop, Turkey
[3] Department of Basic Science, Faculty of Fisheries and Aquaculture, University of Sinop, 57000 Sinop, Turkey
[4] Department of Biology, Faculty of Sciences, Istanbul University,Vezneciler, Istanbul, Turkey
[5] Hydrobiology Department, Fisheries Faculty, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

Abstract
Concentrations of Cd, Co, Cu, Fe, Ni, Pb and Zn were determined in marine algae. Certain macroalgae species were chosen among the green, brown and red algae species at Sinop stations in the Turkish coast of the Black Sea in 2009. The concentrations of the heavy metals Co, Cu and Zn in the present study are higher, but Fe, Ni and Pb are lower when compared with previous study in the same region.
Keywords: Algae, Black Sea, Metals

INTRODUCTION
Sinop is located at the outermost point on the Turkish coast line of the Black Sea. The fishing potential of this region is important for production of fish meal and oil from fresh anchovy fish. The Black Sea has been subject to very high levels of pollution due to industrial activity, municipal wastewaters, agricultural chemicals, oil pollution and airborne particles. The macroalgae species are usually used to indicate heavy metal levels in both estuarine and coastal waters throughout the world. In benthic food webs, macroalgae are key links and they act as time-integrators of pollutants [1]. Sinop is the main station where our investigation on the heavy metal pollution of marine algae have been carried out since 1986, because it is route on the anchovy fish migration [2]. Some papers have been published concerning heavy metal concentrations measured in macroalgae species collected from the Sinop region [3],[4],[5],[6].

MATERIALS AND METHODS
The aim of this study is: (1) to determine the concentration of Cd, Co, Cu, Fe, Ni, Pb and Zn in macroalgae samples collected from different stations of the Sinop region during 2009 and (2) to compare the present results with the similar studies have been carried out in the same region of the Black Sea. 6 sampling stations of macroalgae were establised in Sinop region (Akliman, Pazaryeri, Karakum, Ormankampi, Yaykil, Gerze). The marine algae species were *Enteromorpha intestinalis*, *Enteromorpha linza*, *Ulva lactuca*, *Cladophora serices* (green algae), *Cystoseira barbata* (brown algae)and *Gelidium crinale*, *Ceramium rubrum*, *Corralina officinalis*, *Coralina ssp.* (red algae). About 500 g of the fresh weight were harvested at low tide. The samples were rinsed to remove sand and epiphytal materials (1) in the sea water and (2) then with top water and (3) distilled water. They then were dried at 85 ^{o}C and homogenized. All procedure of the method was similar to that previously described [5]. The concentration of the heavy metals were determined by ICP-MS.

RESULTS
The heavy metal concentrations in marine algae are shown in Table 1. Errors will be calculated from counting statistics. The highest uptake in macroalgae species at the sampling sites were as follows: Cu and Ni in *G. crinale*, Fe and Pb in E. *intestinalis*, Zn in *C. sericea* and Co in *U. lactuaca*. The heavy metals accumulated in different algal taxa were: in green algae, Fe, Pb and Zn; in brown algae Co; in red algae Cu and Ni. The Cd concentrations in tested macro algae samples were found to be below the lower limit detection (<0.01). The highest amounts of heavy metals in macro algae samples were found as: Co and Pb in Akliman; Cu and Ni in Yaykil and Fe and Zn in Karakum.

Tab. 1. Average heavy metal concentrations (mg kg^{-1} dry weight) in marine algae samples of all sampling stations

Station and Species	Co	Cu	Fe	Ni	Pb	Zn
Akliman						
C. barbata	2.72	3.91	373	5..88	<0.01	10.97
E. intestinalis	1.83	3.17	421	4.00	<0.01	45.11
Corallina sso	0.10	0.06	326	3.76	4.84	55.78
U. lactuca	0.75	3.61	567	4.70	<0.01	40.62
E. linza	2.34	4.05	944	8.38	<0.01	24.92
Pazaryeri						
C. barbata	1.02	5.33	81	0.95	<0.01	20.47
U. lactuca	1.01	5.25	117	2.78	<0.01	20.37
Karakum						
C. barbata	2.53	2.01	455	0.79	<0.01	0.08
E. intestinalis	1.54	6.21	1104	2.16	<0.01	0.19
G. crinale	<0.01	16.8	421	9.53	<0.01	0.28
C. rubrum	<0.01	2.65	691	0.28	<0.01	0.28
Ormankampi						
C. barbata	<0.01	4.42	184	9.26	<0.01	13.22
E. intestinalis	0.98	6.41	352	3.41	<0.01	12.87
Yaykil						
C. barbata	0.61	5.87	991	7.47	<0.01	6.84
E. intestinalis	0.03	7.44	1744	2.42	<0.01	21.61
C. sericea	2.09	2.09	1190	1.09	<0.01	63.11
Gerze						
C. barbata	0.99	6.03	272	2.17	<0.01	4.65
U. lactuca	0.06	8.30	223	3.70	<0.01	34.27
C. officinalis	<0.01	1.77	139	2.02	1.39	20.79

CONCLUSION
In previous study, the heavy metal levels were investigated in *C. barbata* and *E .linza* collected from the Sinop during the period of 1998-2000 [6]. Our results showed that Co, Cu and Zn concentrations are higher, but Fe, Ni and Pb levels are lower than in the same macroalgae species collected from the Sinop in 2000. A comparison of the present results with data reported for similar macroalgae species from other Turkish marine environment, suggest that the heavy metal levels are not higher in the Sinop region than Bosphorus and Marmara Sea macroalgae.

References
1 - Fowler, S.W., 1979. Use of marine algae as a reference material for pollutant monitoring and specimen banking. In: Luepke, N.P. (ed.). Monitoring Environmental Materials and Specimen Banking. Martinus Nijhoff, The Hague. Pp. 267-347.

2 - Topcuoglu, S., Kirbasoglu, Ç., Balkis, N., 2004. Heavy metal concentrations in marine algae from the Turkish Coast of the Black Sea, during 1979-2001. *J.Black Sea/Med.Environ*.,10 , 21-44.

3 - Güven, K.C., Topcuoglu, S., Kut, D., Erentürk, N., Saygi, N., Cevher, E., Güvener, B., Öztürk, B., 1992. Metal uptake by Black Sea algae. *Bot. Mar.*, 35, 337-340.

4 - Güven, K.C., Okus, E., Topcuoglu, S., Esen, N., Küçükcezzar, R., Seddigh, E., Kut, D., 1998. Heavy metal concentrations in algae and sediments from the Black Sea coast of Turkey.*Toxicol. Environ. Chem.*, 67, 435-440.

5 - Topcuoglu, S., Kirbasoglu, Ç., Güngör, N., 2002. Heavy metals in organisms and sediments from Turkish coast of the Black Sea, 1997-1998. *Environ.Int.*, 27, 521-526.

6 - Topcuoglu, S., Güven, K.C., Balkis, N., Kirbasoglu, Ç., 2003. Heavy metal monitoring of marine algae from the Turkish coast of the Black Sea, 1998-2000. *Chem.*,52, 1683-1688.

EVALUATION DU TRANSFERT DU CADMIUM LE LONG DE LA CHAINE TROPHIQUE DANS LA REGION DE SKHIRA (GOLFE DE GABES)

Lamia Dammak [1], Asma Hamza [1], Abderrahmen Bouain [2] and Ines Hamdi [2]*
[1] Institut National des Sciences et Technologie de la Mer, 3018, Sfax, Tunisie
[2] Faculté des Sciences de Sfax, 3018, Tunisie - ineshhamdi@yahoo.fr

Abstract
Cette étude porte sur le transfert du Cadmium dans la chaîne trophique, dans la région de Skhira. Il s'agit d'une zone qui est soumise essentiellement au rejet des eaux de refroidissement de la chaîne de traitement des phosphates et du terminal pétrolier Trapsa. Le suivi semestriel de ce métal dans différents organismes récoltés dans la zone a permis de mettre en évidence deux types de transfert : du sédiment vers les phanérogames et du sédiment vers la palourde. Le gradient automne - printemps a été défini.
Keywords: Cadmium, Posidonia, Gulf Of Gabes

Introduction
Ce travail porte sur des chantillonnages semestriels dans la région de Skhira aux abords de l'usine de transformation des phosphates, le port de pêche de Zaboussa et le terminal pétrolier de TRAPSA. Nous avons essayé de déterminer l'accumulation du cadmium dans différents organismes récoltés dans la région afin d'évaluer le transfert le long de la chaîne trophique.

Matériel et Méthodes
La zone Skhira est située à la partie Sud-est de la région de Sfax, elle fait également partie du golfe de Gabès, Sud de la Tunisie. L'échantillonnage (automne et printemps) a ciblé le sédiment, des phanérogames, le bivalve *Ruditapes decussatus* et le sparaillon *Diplodus annularis*. L'analyse a été effectuée sur les espèces *in toto* séchées et broyées. Après minéralisation en utilisant l'acide perchlorique, l'acide chlorhydrique et l'acide nitrique, le dosage du cadmium a été effectué au moyen de la torche à plasma (JY2000).

Résultats et discussions
L'évolution de la concentration moyenne du Cadmium le long de la chaîne trophique est illustrée dans la figure 1.

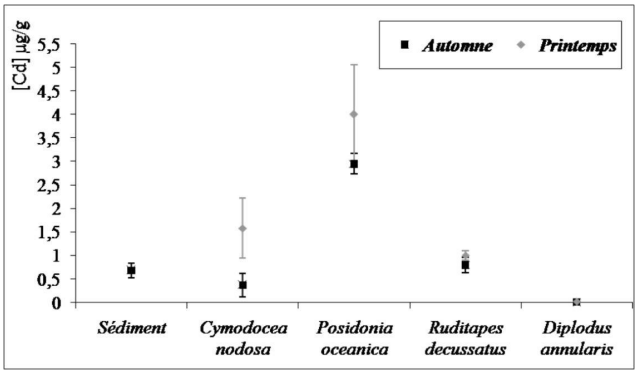


Fig. 1. Evolution de la concentration du Cd dans les organismes de la chaîne trophique, exprimée en µg/g du poids sec, affectée des intervalles de confiance (95%)

L'examen des concentrations en Cd montre une différence dans l'accumulation entre les compartiments en fonction des saisons.
Les valeurs enregistrées dans le sédiment ne dépassent pas 1 µg/g pendant les deux saisons, elles sont par conséquent inférieures à la norme présentée par la Commission Européenne (CE) [1]. Concernant les phanérogames, le Cd s'accumule plus chez la posidonie que chez la Cymodocée. La posidonie concentre plus le Cd au printemps résultant certainement de sa grande masse foliaire. En effet, ce métal se concentre plus dans les parties épigées (faisceaux foliaires) [2]. La posidonie pourrait être un bon indicateur de la pollution dans la zone. Nous remarquons que les concentrations du Cd entre les sédiments et la posidonie sont 3 fois plus importantes. En comparant nos résultats avec ceux de Lafabrie [2] (atteignant un maximum de 14.37 ± 1.44 µg/g poids/sec en Corse), nos valeurs sont assez faibles et cette zone est modérément contaminée. Le gradient croissant automne printemps est justifié par le développement des feuilles et l'accumulation de ce métal à ce niveau. Chez *Ruditapes decussatus*, la valeur maximale mesurée ne dépasse pas les normes fixées par la CE. Cette variation peut être due à l'effet saison, fait d'ailleurs mis en évidence par plusieurs travaux et particulièrement dans le golfe d'Annaba par Solttani et *al.* [3]. En comparant ces valeurs avec celles de la littérature, nous remarquons qu'elles suivent les mêmes intervalles de variation que celles du golfe de Gabès [4]. Le dosage du Cd chez le Sparaillon est <0.2µg/g pour les deux saisons.

References
1 - C.E., 2000. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Official Journal of the European Communities* 43 :1-72.
2 - Lafabrie C., 2007. Utilisation de *Posidonia oceanica* (L.) Delile comme bio-indicateur de la contamination métallique. Thèse de doctorat en Ecologie Marine.Université du Corsica :151p.
3 - Solttani N., Taaya H., Sifi K. et Beldi H., 2007. -Variations saisonnières de deux biomarqueurs (MDA, LDH) chez *Donax trunculus* dans le golfe d'Annaba : corrélation avec le métabolisme lipido-glucidique et la pollution métallique. Acte de la 81ère journée tunisienne des sciences de la mer (Tabarka).
4 - Chouba L., Zamouri Langar N., El Abed A., 1998.- Le réseau de surveillance des contaminants nocifs: les métaux lourds dans la chaire de la clovisse. INSTM. Acte des Acquis de recherche Agronomique et vétérinaire IRESAT –n°5.

ORGANIC MATTER IN THE KOTOR BAY, SOUTH ADRIATIC SEA

Jelena Dautovic [1]*, Vjerocka Vojvodic [1] and Bozena Cosovic [1]
[1] Rudjer Boskovic Institute - jdautov@irb.hr

Abstract

Dissolved organic carbon (DOC), particulate organic carbon (POC) and surface active substances (SAS; NF – nonfiltered, dissolved and particulate, F – filtered, dissolved) were studied seasonally from April 2008 to March 2009 at three locations in the Kotor Bay, Montenegro. Concentrations of reactive part of organic matter displaying surface active properties were compared to the related DOC and POC contents. Temporal distributions are presented in the surface and the bottom layer.

Keywords: Organic Matter, Adriatic Sea

Tab. 1. Ranges of average values obtained for different parameters

	surface	bottom
Salinity	7.5 - 25.9	35.7 - 36.9
Temperature (°C)	11.40 - 27.30	12.93 - 18.53
SAS NF (mg/L)	0.069 - 0.219	0.055 - 0.098
SAS F (mg/L)	0.088 - 0.196	0.045 - 0.091
DOC (mg/L)	0.685 - 1.172	0.842 - 0.971
POC (mg/L)	0.187 - 0.541	0.048 - 0.127

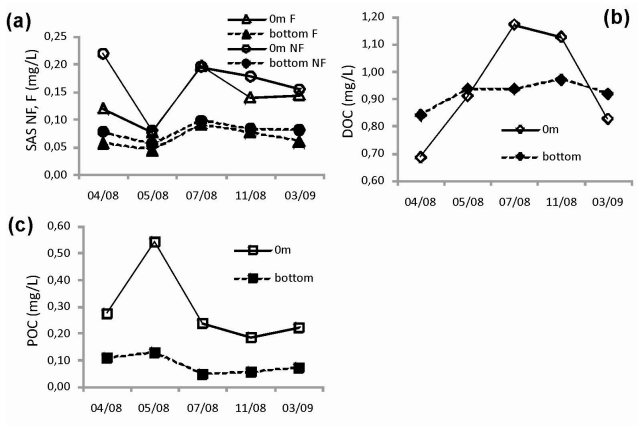


Fig. 1. Seasonal variations of average SAS NF, SAS F (a), DOC (b) and POC (c) in the surface and the bottom layer

Introduction

Boka Kotorska is one of the best indented parts of the south Adriatic Sea. It is characterised by considerable precipitation quantities and is considered among the rainiest parts of Europe. Coastal Dinaric classical karst of Montenego is characterised by high degree of karstification and tectonic rupture of carbonate rocks and of flysh barriers [2] which swallow huge quantities of freshwater creating a permanent freshwater inflow to the bay leading to an increase in biological activity (phytoplankton blooms) and, hence, in organic matter content.

Methods

For determination and characterization of organic matter electrochemical method a.c. voltammetry with a nonionic model T-X-100 as a standard was used. DOC and POC analysis were done by high temperature catalytic oxidation (HTCO) method. Emphasis is given to the results obtained for surface and bottom samples since great differences are observed among them – bottom layer is monotonous and less variable in all studied parameters (Table 1).

Results

Permanent nutrient inflow and low salinity (permanent freshwater input) lead to an increase in biological activity (phytoplankton bloom) during 04/2008 confirmed by the highest average SAS NF value indicating presence of fresh, surface reactive organic material in the surface layer (Fig. 1a). With time, fresh organic material SAS NF is transferred in the dissolved fraction accompanied with an increase in average DOC concentration (Fig. 1b). In 07/2008 new surface active material is visible, indicating another increase in biological activity (Fig. 1a). DOC concentration reaches it's maximum average value in the summer period (Fig 1b). During autumn and winter average SAS and DOC concentrations continue to decrease (Fig. 1a, 1b). Average POC values increase from April to May reaching a maximum value, and then decrease slowly toward winter followed by an increase again in 03/2009 (Fig 1c). Interestingly, bottom average DOC values are higher than surface average DOC values in the spring (04/2008, 05/2008, 03/2009).

Acknowledgements

The financial support of the project „Marine science and coastal management in the Adriatic, western Balkan. An education and research network“ is gratefully acknowledged

References

1 - Krivokapic S. 2008. Chlorophyll a as biomass indicator in the Boka Kotorska Bay. BALWOIS 2008 – Ohrid, Republic of Macedonia – 27, 31 May 2008

2 - Magas D. 2002. Natural-geographic characteristics of the Boka Kotorska area as the basis of development. *Geoadria*, 7/1, 51-81

AEOLIAN DUST DEPOSITION IN THE WESTERN MEDITERRANEAN, AND THE PROJECT CHARMEX

F. Dulac [1]*, K. Desboeufs [2], B. Laurent [2], E. Bon Nguyen [2], C. Schmechtig [2], G. Bergametti [2], R. Losno [2], B. Marticorena [2], C. Guieu [3] and M. D. Loÿe-Pilot [4]

[1] LSCE, UMR 1572 CEA-CNRS-UVSQ, Gif-Sur-Yvette, France, and LISA, UMR 7583 - francois.dulac@cea.fr

[2] LISA, UMR 7583 UP12-UP7-CNRS, Créteil, France

[3] LOV, UMR 7093 CNRS-UPMC, Villefranche-Sur-Mer, France

[4] CERES-ERTI, Ecole Normale Supérieure, Paris, France

Abstract

Evidences of the impact of desert dust deposition on the biogeochemistry of surface marine waters call for atmospheric dust transport models to provide deposition fluxes. Dust deposition observations are critically needed to constrain the models. Here we show a compilation of (i) past results on dust deposition in the western Mediterranean, (ii) new measurements from Corsica obtained in the framework of the project DUNE, and (iii) CHIMERE-Dust model results, compared with 1-yr measurements from the project ADIOS. We finally advertise for a new deposition monitoring network and model validation effort in the framework of the project ChArMEx.

Keywords: Atmospheric Input, Western Mediterranean

Results on total dust deposition (eventually based on Al used as a tracer based on an average content of 7.1 to 8.2%) in the western Mediterranean are relatively scarce in the literature. They are widely dispersed in space and time, spanning from October 1982 to May 2002 at various sites from Campo de Gibraltar in southern Spain to the French Riviera, including island sites in Sardinia and Corsica. Yearly deposition fluxes range from about 2 to 26 g m^{-2}. Since late March 2008 a new monitoring station has been operated with a weekly sampling time step at Galeria (42.44°N; 8.65°E) on the western coast of Corsica in the framework of the project DUNE (a Dust Experiment in a Low-Nutrient Low-Chlorophyll Ecosystem). Figure 1 illustrates that no event larger than 0.45 g m^{-2} was recorded in one year so that the yearly flux is among the lowest ever observed in Corsica (2.9 g m^{-2}).

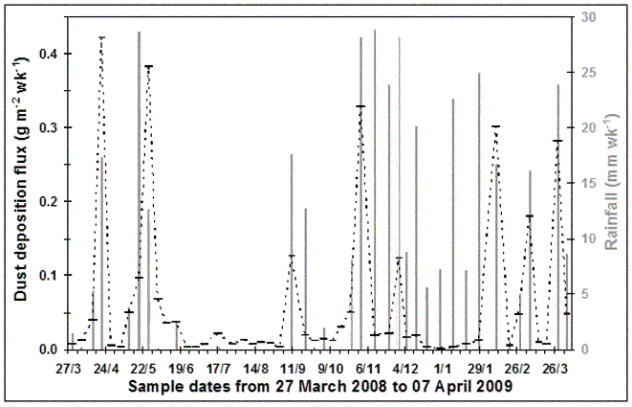


Fig. 1. Weekly dust deposition flux (horizontal dashes) based on an average Al content of 8.1% in soil dust, and rainfall (vertical bars) at Galeria, Corsica.

A 12-yr time continuous record obtained in Corsica[1] shows that interannual variability is high and precludes integrating non coincident data from various stations for studying spatial trends. During the ADIOS programme a few deposition sampling stations were operated simultaneously on a monthly basis from June 2001 to July 2002. Results show a factor of 4 range in yearly dust deposition fluxes, with the lowest values near Gibraltar and the highest in Corsica [2] not only reflecting the precipitation distribution.

Preliminary simulations of African dust deposition with the transport model CHIMERE-Dust[3] are compared with ADIOS observations and indicate that deposition data are necessary to constrain the dust transport budget in addition to optical depth observations. To better constrain the spatial variability of dust deposition fluxes, in the framework of the project ChArMEx (the Chemistry-Aerosol Mediterranean Experiment; http://charmex.lsce.ipsl.fr), we shall set up from late 2010 a new monitoring network of 10 stations in the western Mediterranean (Figure 2) to be operated for a 3-yr period with a 2-wk time step based on a new autonomous sampler under development. We propose that the network is completed in the western basin and enlarged to the eastern basin thanks to international collaborations.

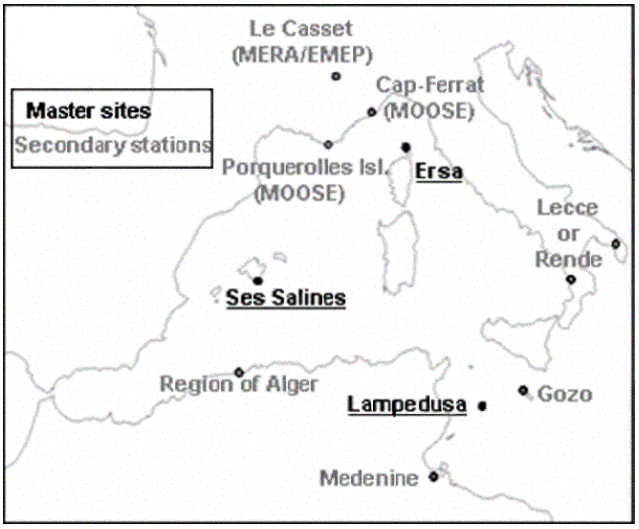


Fig. 2. Future network of total insoluble deposition measurement. Master sites on islands will include soluble and insoluble deposition fluxes of Fe, P, N, Si and C, and total flux of Hg.

References

1 - Loÿe-Pilot M.D. and Martin J.M., 1996. Saharan dust input to the western Mediterranean: an eleven years record in Corsica. *In*: Guerzoni, S., Chester, R. (eds.), The Impact of Desert Dust Across the Mediterranean. Kluwer, Dordrecht, pp. 191-199.

2 - Guieu C., Loÿe-Pilot M.-D., Benyahya L. and Dufour A., 2009. Spatial variability of atmospheric fluxes of metals (Al, Fe, Cd, Zn and Pb) and phosphorus over the whole Mediterranean from a one-year monitoring experiment: Biogeochemical implications. *Mar. Chem.*, doi:10.1016/j.marchem.2009.02.004.

3 - Menut L., Forêt G. and Bergametti G., 2007**.** Sensitivity of mineral dust concentrations to the model size distribution accuracy, *J. Geophys. Res.*, 112, D10210, doi:10.1029/2006JD007766.

DISTRIBUTION MÉTALLIQUE DANS LES EAUX ET LES SÉDIMENTS DU LITTORAL DE LA BAIE DE TANGER. RIF NORD OCCIDENTAL MAROC

A. El Arrim [1]*, A. Raissouni [1], M. Wahbi [1], M. Maatouk [1], A. Afailal Tribak [1] and B. El Moumni [2]
[1] Faculté des Sciences et Techniques (FST) Tanger. Univ. Abdelmalek Essaidi - elarrimk@yahoo.fr
[2] Faculté Polydesciplinaire de Laarache

Abstract
La pression urbaine et la poussée industrielle sur le littoral de la baie de Tanger a conduit à l'augmentation de la pollution anthropique des eaux marines. L'évaluation de la pollution des eaux dans la baie de Tanger a été appréciée à travers cette étude qui porte sur l'analyse des eaux de surface et des sédiments superficiels. L'analyse a concerné essentiellement les éléments métalliques. Les résultats démontrent une pollution domestique et industrielle assez inquiétante.
Keywords: Sediments, Pollution

Introduction
Ce travail porte, pour la première fois, sur l'étude des éléments métalliques dans les eaux de surface du littoral de la baie de Tanger et l'évaluation de l'état de contamination du milieu par les polluants métalliques. Il constitute également un complément important aux études sédimentologiques, minéralogiques et géochimiques effectuées sur le littoral de la baie de Tanger et les principaux oueds qui y débouchent.[1]. La baie de Tanger se situe au NW du Maroc, sur la rive sud du détroit de Gibraltar, entre 35°46' et 35°48' de latitude Nord, 5°45'20" et 5°49'00" de longitude Ouest.[2].

Méthodologie
L'étude a concerné l'analyse des eaux de surface et les sédiments superficiels de la baie de Tanger. Des prélèvements ont également été réalisés dans les principaux oueds drainant l'arrière-pays de la baie de Tanger : O. Mghogha, O. Souani, O. Mlaleh et O. Chatt ainsi qu'au niveau de la canalisation majeure des eaux usées : O. Lihoud et Rejet Port. L'analyse des eaux a porté sur la détermination des paramètres physico-chimiques (T°, pH, Conductivité, Oxygène dissous, saturation en Oxygène, MES), sur le dosage des éléments métalliques (Cd, Cu, Fe, Mn, Ni, Pb, Zn) et sur le dosage des éléments nutritifs (P, S, NO_3, NH_4).

Résultats et discussion
Les concentrations des éléments métalliques, (en ppb), enregistrées dans les eaux de surface de la baie de Tanger : Cd (2.3-2.6), Cu (71.3-74.3), Pb (99-105), Zn (3.5-22), Fe (16-40.3), Mn (0,11-3,01), Ni (4-18,7) sont en général élevées en comparaison à celles mesurées dans d'autres secteurs péri-méditerranéens similaires. Les teneurs moyennes sont plus faibles que celles enregistrées dans les oueds débouchant dans la baie. Les moyennes des teneurs en éléments métalliques dans les sédiments superficiels de la baie de Tanger sont plus faibles que celles des oueds : Pb (99-105 µg/g), Zn (3.5-22 µg/g), Cu (71.3-74.3µg/g), Cr (67,8 µg/g), Ni (4-18,7µg/g), Mn (0,11-3,01 µg/g) Fe (16-40.3 µg/g) Cd (2.3-2.6 µg/g). Ces valeurs avoisinent et dépassent parfois celles trouvées dans d'autres secteurs méditerranéens, les valeurs maximales coïncidant avec des teneurs élevées de la fraction fine (<40 µm) et en matière organique. Les faibles concentrations se trouvent dans le secteur Est de la baie, ou prédominent des sédiments sableux. Ces résultats indiquent une évolution décroissante des concentrations en métaux de l'ouest vers l'est et de la côte vers le large de la baie, subdivisant ainsi le milieu étudié en deux secteurs bien différenciés, le premier à l'est, soumis à l'action des houles NE dominantes et le deuxième, à faible régime hydrodynamique, bien protégé par les aménagements portuaires des courants engendrés par les houles du secteur NW. La distribution spatiale de ces teneurs en métaux lourds dans les eaux et les sédiments de la baie de Tanger se localisent dans le secteur ouest à proximité des principales embouchures des oueds (Souani et Mghogha) et du port de la baie. Les fortes variations des teneurs en métaux témoignent de l'existence de plusieurs sources de pollution.[3]et [4].

Conclusion
La concentration de ces éléments semble être liée :
- aux rejets des affluents domestiques et industriels (produits toxiques, détergents, métaux lourd...) qui arrivent directement dans la baie par les oueds (Souani et Mghogha) ;
- à la dispersion du panache ; sortie du rejet, situé à 500 m au nord-ouest de la jetée principale du port, véhiculant une partie des apports et des eaux usées du rejet vers la baie par l'action combinée du transit littoral NW et NE ;
- à l'activité portuaire (rejets d'hydrocarbures, produits chimiques,…..).

References
1 - Achab M., El Arrim A., EL Moumni B. and El Hatimi I., 2007. Metallic pollution affecting the bay of Tangier and its continental emissaries: anthropic impact. *Thalassas*, 23 (2): pp. 23-36
2 - El Arrim A., Maatouk M., El Moumni B., El Hatimi I. and Afailal Tribak., 2002. Les sédiments superficiels de la baie de Tanger. Maroc : nature et origine. *Africa Geoscience Review*.Vol.9, N° 3/4 pp.245-253.
3 - El Hatimi I., Achab M. et El Moumni B., 2002. Impact des émissaires et canalisation sur l'environnement de la baie de Tanger : approche pluridisciplinaire.*Bull. Inst. Sci. Rabat*. 24: pp 49-58
4 - Raïs, M. and Gueddari. M., 1998. Chimical forms of Pb, Zn and Cu in surficial sediments from the Golf of Tunis. *15th Int. Sed. Cong*. Alicante, pp. 647-648.

LES HYDROCARBURES DE LA PHASE PARTICULAIRE DES EAUX DE LA BAIE DE TANGER (DÉTROIT DE GIBRALTAR)

H. Er-Raioui [1], S. Bouzid [1]*, S. Khannous [1], I. Bouloubassi [2] and A. Saliot [2]

[1] Equipe Géosciences et Environnement, Département de Sciences de la terre. Faculté des Sciences et Te - sur24@yahoo.fr

[2] Laboratoire d'Océanographie et du Climat : Expérimentation et Approches Numériques, LOCEAN – Université Pierre et Marie Curie

Abstract

Les concentrations en hydrocarbures aromatiques et non aromatiques ont été déterminées au niveau de la matière particulaire des eaux de surface de la baie de Tanger. Les hydrocarbures totaux ont été extraits et fractionnés sur colonne de silice en hydrocarbures aromatiques et non aromatiques. Ces dernières analysées par des techniques chromatographiques, montrent des concentrations relativement importantes (HNA: 36-276 µg/l; HA: 49-133 µg/l). L'étude qualitative a permis de mettre l'accent sur la nature pétrogénique des apports avec une faible présence de la trace des apports biogènes liés aux plantes supérieures.

Keywords: Coastal Waters, Particulates, Pollution, Western Mediterranean, Geochemistry

Introduction

La Méditerranée marocaine est une zone d'intérêt économique par excellence pour le Maroc. Elle est sous l'influence des évacuations industrielles et urbaines émanant des villes côtières. La situation est dangereuse étant donné le trafic commercial important. Plusieurs millions de tonnes d'hydrocarbures transitent par le détroit de Gibraltar chaque année. A cela, s'ajoute l'effet des événements en mer dont le nombre est d'environ 60 par an, d'où l'intérêt de mettre l'accent sur le bilan de la pollution des côtes marocaines par les hydrocarbures et notamment au niveau des sites potentiels de gisement halieutiques et des sites d'attraction touristique. Les eaux de la baie de Tanger, située à l'entrée de la Méditerrané, sont sujettes à toutes ces agressions, faisant ici l'objet de l'évaluation de la contamination par les hydrocarbures.

Matériels et méthodes

Huit échantillons d'eau ont été prélevés à la surface de la baie de Tanger en quantité de 10 litres et filtrés sur un filtre GF/F de 15 cm de diamètre et de 0,7µm de porosité. les filtres ont subit ensuite une extraction effectuée selon le protocole de Bligh and Dyer [1] modifié, où le chloroforme est remplacé par le dichlorométhane. L'extrait a été ensuite fractionné sur une colonne de silice en hydrocarbures non aromatiques (HNA) et hydrocarbures aromatiques (HA). Ces deux dernières ont été analysées par chromatographie en phase gazeuse (CG-FID) et chromatographie couplée (CG/SM). La quantification est obtenue à l'aide des standards internes deutérés.

Résultats et discussions

Les hydrocarbures non aromatiques montrent des concentrations qui varient de 36,3 ±0,4µg/l à 276,47±0,5µg/l. Ces valeurs restent élevées en comparaison avec d'autres endroits en Méditerranée [2,3]. Les hydrocarbures aromatiques montrent également des concentrations de 49,74 ±0,6µg/l à 133,62 ±0,4µg/l. L'observation de la distribution spatiale de ces concentrations révèle une étroite liaison entre les niveaux de concentration et la proximité aux sources de pollution (port et embouchure des rejets urbains) d'une part et d'autre part avec les mouvements des masses d'eau à l'intérieur de la baie. Les chromatogrammes des HNA (figure 1) montrent une distribution uni-modale centré sur n-C29 - n-C31. Certains échantillons montrent une légère prédominance des composés impairs n-C27 - n-C29 - n-C31 relatifs à une origine terrestre dérivant des cires des plantes supérieures [4]. Dans l'ensemble, les n-alcanes ne montrent aucune prédominance entre composés pairs et impairs, ce qui est généralement traduit par l'indice d'imparité CPI (Carbon Preference Index) au voisinage de l'unité. Ces valeurs avec la présence des doublets n-C17 pristane et n-C18 phytane et de l'UCM (Unresolved Complex Mixture) dans la majorité des chromatogrammes, mettent en évidence la contribution d'une source anthropique pétrolière. Cette dernière a été confirmée par la présence des composés hopanes en série C27-C35 ayant la configuration 17α (H), 21β (H) caractéristiques d'une contamination pétrolière [5,6].

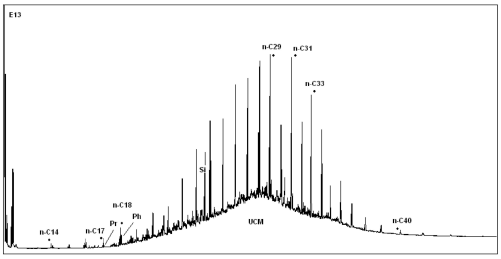


Fig. 1. Chromatogrammes de la fraction "hydrocarbures non aromatiques" obtenus par CG/DIF pour un échantillon d'eau de la baie de Tanger

Les hydrocarbures aromatiques montrent un mélange de composés possédant des groupements phényle traduisant ainsi les traces d'une activité industrielle de teinture, de plastique etc.

References

1 - Bligh E.G., Dyer W.J., 1959. A rapid method of total lipid extraction and purification. *Can. J. Biochem. Phys*., 37: 911-917.

2 - Bouloubassi I,Saliot A.,1993, Dissolved particulate and sedimentary naturally derived polycyclic aromatic hydrocarbons in a coastal environment: geochemical, significance. *Mar. Chem*, 42: 127-143.

3 - Dachs J., Bayona J.M., Fillaux J., Saliot A., Albaigés J., 1999. Evaluation of anthropogenic and biogenic inputs into the western mediterranean using molecular markers. *Mar. Chem*., 65: 195-210.

4 - Saliot A., Parrish C.C., Sadouni N., Bouloubassi I., Fillaux J., Cauwet G., 2002. Transport and fate of Danube Delta terrestrial organic matter in the Northwestern Black Sea mixing zone. *Mar. Chem*., 79: 243-259.

5 - Philp R.P.,1985. Fossil fuel biomarkers. Applications and spectra. Meth.Geochem. *Geophys*. 8 (2): 6-31.

6 - Peters K.E., Moldowan J.M., 1993. The biomarker guide: interpreting molecular fossils in petroleum and ancient sediments, *Prentice Hall*, New York., pp 61-98.

RELATIONSHIP BETWEEN THE DISTRIBUTION OF ORGANIC MATTER AND NUTRIENTS IN THE NORTHEAST MEDITERRANEAN (MERSIN BAY)

Emine Erdogan [1], Özden Bastürk [1], Süleyman Tugrul [2] and Fatih Sert [2]*
[1] Mersin University,Faculty of Fisheries
[2] Middle East Technical University, Institue of Marine Sciences - fsert@ims.metu.edu.tr

Abstract
In the present study, 6 field studies were performed in the Mersin Bay during September 2008 – August 2009. Nitrate (NO_3+NO_2) concentrations varied between 3.6-10.8 µM in the river-fed nearshore waters, whereas phosphate (o-PO4) ranged merely between 0.02-0.14 µM, exhibiting higher N/P ratio (35-50) in the nearshore zone. Surface distributions of total phosphorus (TP), chlorophyll-a (CHL) and particulate organic matter (POC, PON, PP) displayed similar spatial patterens in the productive shelf waters. TP and CHL contents of the polluted nearshore waters were 0.43 µM and 2.0µg/L, respectively,as the offshore values were as low as 0.02 µM for TP and 0.02 µg/L for CHL. Particulate-P ranged between 0.01-0.41 µM in the bay waters.
Keywords: Nutrients, Organic Matter, Particulates

Introduction

The Eastern Mediterranean is a typical example for the oligotrophic water masses of the world ocean system [1-3]. However, Cilician shelf zone of the northeastern Mediterranean have been polluted by discharges of the major rivers (Seyhan, Ceyhan) and domestic wastewaters of the Mersin and Iskenderun cities. In recent decades, eutrophication phenomena have increased in the river-fed shallow zone of Mersin Bay. This study aims to assess eutrophication and water quality of the Mersin bay, covering the region extending from Mersin city coastal zone up to the east of Seyhan river mouth (Fig. 1).

Results

Six field surveys were conducted by R/V BILIM during the September, 2008-August, 2009 period within the framework of the (TÜBITAK-106G66) project. Hydrographic data were obtained by a CTD probe coupled to a 12-bottle Rozette system. Chemical results were obtained by the conventional methods [1-3]. Concentrations of nutrients, organic matter (POM) biomass (CHL-a) were markedly high in the shallow nearshore zone during the year; light transparency was very low, due to large river discharges and limited ventilation of the nearshore zone by open sea (Fig. 1, 2). POC/PON ratio generally ranged between 7 and 8. Surface nitrate and PO_4 values were as low as 0.1-0.2 and 0.02-0.05 µM, respectively, in the bay offshore waters, consistent with NE Mediterranean open water values [1-3]. The nitrate/phosphate (N/P) molar ratio increased from levels of 8-15 in offshore waters to 35-50 in the nearshore zone fed by nitrate-replete river discharges. Thus, the N/P ratio is mainly dominated by nitrate changes in the P-depleted surface waters. Surface CHL concentrations, as low as 0.02 µg/L in offshore waters, increased markedly up to 2 µg/L level in the river-fed nearshore waters. Particulate-P values were as high as 0.36-0.40 µM in polluted shallow zone, decreasing to very low levels of 0.01-0.02 µM in offshore waters of the bay.

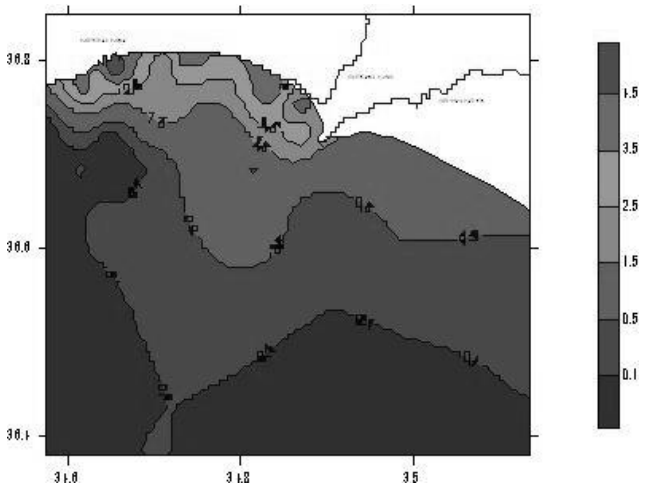


Fig. 1. Monitoring of Mersin Gulf Eutrophication: Surficial distribution of pollutant parameters (April 2009) Nitrates (NO3+NO2 (µM))

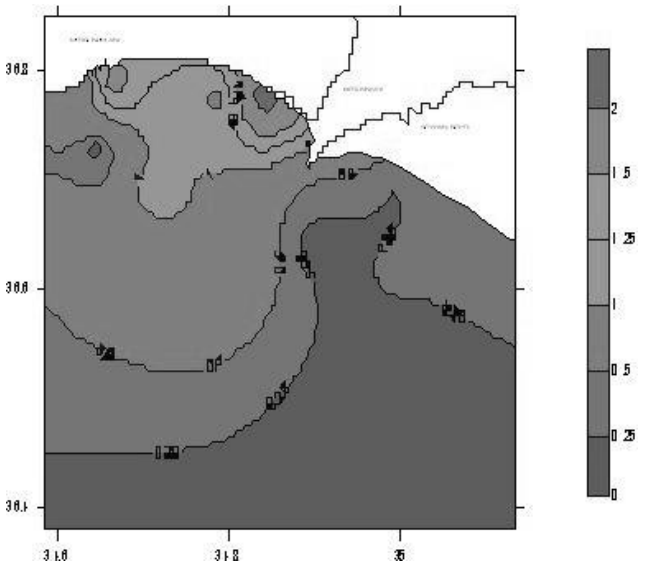


Fig. 2. Monitoring of Mersin Gulf Eutrophication: Surficial distribution of pollutant parameters (April 2009) total Chl-a (µg/L)

References

1 - Tugrul S., Yemenicioglu S., Ediger D., Uysal Z., Mutlu E., Dogan-Saglamtimur N., Yilmaz D., Devrimci H. A., 2005. Med Poll Phase III Long Term Bio Monitoring Trend Monitoring, Compliance Monitoring and Eutrofication Monitoring Program in Coastal and Hot Spot Areas from Northeastern Mediterranean Final Report 2005, Ministry of Environment and Forestry Turkey, Pp: 336.

2 - Yilmaz A., Bastürk Ö., Saydam C., Ediger D., Yilmaz, K., Hatipoglu, E., 1992. Eutrophication in Iskenderun Bay, Northeastern Mediterranean. Sci. Tot. Environ. (Special Issue). In: Marine Coastal Eutrophication (Vollenweider, R.A., Marchetti, R., Viviani, R., eds.) Elsevier, Amsterdam, pp: 705-717.

3 - Yilmaz A., Tugrul S., 1998. The effect of cold- and warm- core eddies on the distribution and stoichiometry of dissolved nutrients in the northeastern Mediterranean, *Journal of Marine Systems*, 16, 253-268.

4 - Krom M. D., Woodward E. M. S., Herut B., Kress N., Carbo P., Mantoura R. F. C., Spyres G., Thingstad T. F., 2005. Nutrient cycling in the south east Levantine basin of the eastern Mediterranean: Results from a phosphorus starved system, *Deep-Sea Research II*, 52, 2879-2896.

HEAVY METAL CONCENTRATIONS IN BIOTA, SEDIMENT AND SEA WATER SAMPLES FROM DIL ISKELESI REGION

H. A. Ergul [1], U. Ay [2], A. Karademir [3]*, B. Cayir [1], S. Topcuoglu [4], B. Telli [4] and M. Terzi [4]
[1] Kocaeli University, Department of Environmental Engineering, Kocaeli, Turkey - aykan@kocaeli.edu.tr
[2] Kocaeli University Department of Biology, Kocaeli, Turkey
[3] Kocaeli University Department of Chemistry, Kocaeli, Turkey
[4] Istanbul University, Department of Biology , Istanbul, Turkey

Abstract
Concentrations of Zn, Fe, Mn and Pb were determined in biota, sediment and sea water samples collected seasonally from two stations in the Marmara Sea in Turkey. The levels of Fe and Mn in biota and Zn, Mn and Pb in sediment samples were higher than the previous studies. The order of heavy metal concentrations in all samples was: Fe > Mn > Zn > Pb.
Keywords: Metals, Bivalves, Sediments, Marmara Sea

Introduction
Dil Iskelesi is located in the east of the Marmara Sea. Dil stream is one the most polluted streams of Turkey passing through Dilovasi and carries untreated effluent from its basin to the Dil Iskelesi (Izmit Bay-Marmara Sea). Besides the effluents of 34 (total of 171) heavy industrial plants located in the Dilovasi, the wastewaters of more than 400.000 people are discharged to Izmit Bay from Dil Iskelesi region via Dil stream. The objective of this study is to understand the biogeochemical composition of some heavy metals on Dil Iskelesi shore under different seasonal conditions.

Materials and methods
Two sampling stations were chosen on Dil Iskelesi inshore. The first station is located next to a huge metallurgy plant cooling water discharge at a distance of 50 m from the shore. Second station was chosen in front of the Dil stream at a distance of 250 m west from 1st station (Fig. 1).



Fig. 1. Stations at Dil Iskelesi (Izmit Bay-The Marmara Sea)

Ulva lactuca (macro algae), *Mytilus galloprovincialis* (bivalvia), P*aracentrotus lividus* (echinoderm), sea water and sediment samples were collected from these stations between summer 2008 and autumn 2009. For metal analysis in biota samples, whole soft parts of *M. galloprovincialis* and soft parts, Aristotle's lantern and shell of *P. lividus* were dissected and washed with bidistilled water. Biota and water samples were analyzed by flame atomic absorption spectrophotometer for Zn, Fe and Mn and by graphite furnace for Pb. The sediment samples were analyzed by ICP-MS. Other procedures of the methods were described previously [1, 2].

Results and Discussion
The maximum heavy metal levels were determined in autumn for both stations except Pb at 1st station in *U. lactuca*. Higher Zn, Mn and Pb levels were found in summer while Fe in autumn at 2nd station in *M. galloprovincialis*. In *P. lividus*, Zn and Pb levels were higher in soft parts while Fe and Mn levels were high in shell in lantern parts, respectively. In sediment samples, the metal levels in summer season were higher for all metals. All metal levels in the sediment samples were higher than those in biota samples. In the sea water samples metal levels close to each other. However Fe levels were higher in autumn while Mn in summer (Table 1). Among the biota samples, higher Zn and Pb levels were found in mussel while Fe and Mn in algae samples. While Zn levels were higher at 2nd station, Mn levels at 1st station both algae and sea water samples in summer and autumn seasons. Pb and Fe levels were higher at 1st station in summer and 2nd station in autumn season.
Compared with the literature data, our results in biota and sediment are generally at the same level or higher than the other Marmara Sea studies [1, 3, 4]. The Fe and Mn levels in the present study are clearly higher than the biota samples collected from the different locations of the Marmara Sea. On the other hand, Pb levels in biota samples in the present study are slightly lower than those given in previous results. Zn, Mn and Pb levels in the sediment samples are higher than the levels observed in other Marmara Sea locations except for Mn in the Gulf of Gemlik. The Fe levels in the sediment samples are lower than those in Erdek Bay of the Marmara Sea [4]. Acknowledgements This study was funded by TÜBITAK (Grant No: 107Y261) and Kocaeli University (Grant No: 2008/017)

Tab. 1. Heavy metal concentrations in biota sediment (µg g^{-1} dry wt) and sea water (µg ml^{-1}) samples from Dil Iskelesi shore of Izmit Bay

Season	Station	Zn	Fe	Mn	Pb
Ulva lactuca (mean dry wt (%) in Summer at 1st, 2nd station and Autumn at 1st, 2nd station were 11.3, 6.1 and 14.2, 7.0 respectively)					
Summer 2009	1	98.4 ± 0.01	2305.7 ± 0.60	92.8 ± 0.01	1.6 ± 0.01
	2	153.5 ± 0.10	732.1 ± 1.10	50.3 ± 0.01	0.5 ± 0.01
Autumn 2009	1	149.7 ± 0.01	5229.5 ± 1.10	294.5 ± 0.10	0.5 ± 0.01
	2	223.4 ± 0.01	5270.1 ± 0.20	219.2 ± 0.10	3.4 ± 0.01
Mytilus galloprovincialis (mean dry wt (%) in Summer and Autumn were 15.7 and 15.6 respectively)					
Summer 2009	2	250.2 ± 0.20	335.1 ± 0.40	14.9 ± 0.01	5.5 ± 0.20
Autumn 2009	2	237.6 ± 0.10	468.4 ± 0.60	4.8 ± 0.01	3.9 ± 0.01
Paracentrotus lividus (Soft Part (mean dry wt 14.1%), Lantern, Shell respectively)					
Autumn 2009	1	49.8 ± 0.01	81.5 ± 0.01	9.7 ± 0.01	0.5 ± 0.01
		27.4 ± 0.01	4.7 ± 0.01	191.2 ± 0.10	0.1 ± 0.01
		36.7 ± 0.01	205.6 ± 0.10	39.4 ± 0.01	0.02 ± 0.01
Sediment					
Summer 2008	2	613 ± 34	25100 ± 150	670 ± 44.5	108.5 ± 2.1
Autumn 2008		356 ± 13	19400 ± 100	513 ± 7.2	60.7 ± 1.6
Sea water					
Summer 2008	1	0.015 ± 0.011	<0.001	0.086 ± 0.001	<0.01
	2	0.033 ± 0.001	0.003 ± 0.001	0.082 ± 0.001	<0.01
Autumn 2008	1	0.007 ± 0.007	0.018 ± 0.001	0.034 ± 0.001	<0.01
	2	0,032 ± 0.008	0.015 ± 0.001	0.033 ± 0.001	<0.01

References
1 - Topcuoglu, S., Kirbasoglu, Ç., Yilmaz,Y.Z. 2004. Heavy metal levels in biota and sediment samples in the northern coast of the Marmara Sea. *Environ.Monit.Assess*., 96,183-189.
2 - Ergul,H.A.,Topcuoglu,S.,Olmez,E.,Kirbasoglu,Ç. 2008. Heavy metals in sinking particles and bottom sediments from the eastern Turkish coast of the Black Sea. *Estuar.Coast.Shelf Sci*., 78, 396-402.
3 - Unlu,S. Topcuoglu,S., Alpar,B., Kirbasoglu,Ç., Yilmaz,Y.Z. 2008. Heavy metal pollution in surface sediment and mussel samples in the Gulf of Gemlik.*Environ.Monit.Assess*.,144,169-178.
4 - Balkis, N.,Cagatay,M.N. 2001. Factor controlling metal distributions in the surface sediments of the Erdek Bay, Sea of Marmara,Turkey. *Environ.Int*., 27,1-13.

THE EFFECT OF WEIGHT AND CONDITION INDEX IN MUSSEL ON HEAVY METAL CONCENTRATIONS IN IZMIT BAY

Halim Ergül [1]* and Betül Çayir [1]

[1] Kocaeli University Science and Art Faculty Department of Biology, Kocaeli, Turkey - halim.ergul@kocaeli.edu.tr

Abstract

The body weight and condition index (*CI*) effect on concentrations of Pb, Zn, Mn and Fe were investigated in Mytilus galloprovincialis soft tissue at two different locations in the Izmit Bay. A negative correlation between soft tissue dry weight and metal concentrations was clear in Mn and Fe. On the other hand, Zn and Pb levels decreased with increasing *CI* value.

Keywords: Metals, Bivalves, Marmara Sea

Introduction

It is well known that mussels are good bioindicators for heavy metals. Several internal (e.g. body size, body weight, shell size, age, filtering capacity) and external factors (e.g. waves, tidal exposure, salinity, temperature) effect the metal accumulation in mussel tissues. Literature data shows a relation between body size and metal accumulation in mussel soft tissue [1]. In general metal accumulation is negatively correlated with body size but some studies reported that metal concentrations in molluscs can be independent of body size [2]. The objective of this study is to evaluate the some metal concentrations in different sizes of *Mytilus galloprovincialis* soft tissues at the two different locations from Izmit Bay (The Marmara Sea) (Fig. 1).

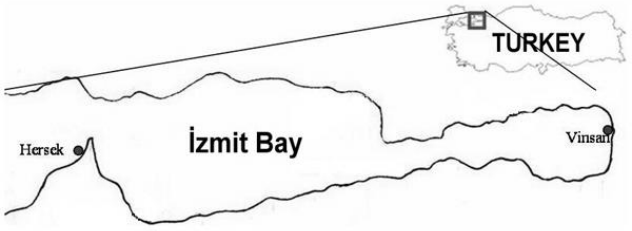


Fig. 1. Station locations in Izmit Bay (The Marmara Sea).

Material and Methods

The mussels were collected on April 2009 from the coast line 100-200 m lengths from Vinsan, a stagnant area under the effect of untreated wastewater and from Hersek, a waving area located next to shipyards in the Izmit Bay (The Marmara Sea). At least 30 individual mussels in 5 different size (3, 4, 5, 6, 7cm ± 2mm) were measured with Wernier calipers with 0,1 mm sensitivity, dissected, dried and weighed same as the shells. Condition index (CI) was calculated by dry tissue and dry shell weight. For metal analyses whole soft parts were analyzed by flame atomic absorption used for Zn, Fe and Mn and graphite furnace for Pb. Detailed method is described previously [3]. Power function was used for plotting graphics for the effect of body size on metal concentrations.

Results and Discussions

Pb, Mn and Fe levels were higher in Vinsan while Zn in Hersek station. A negative correlation between soft tissue dry weight and metal concentrations was clear in Mn and Fe at both stations, and for Pb at Hersek station. On the other hand, contrary to general literature, Zn levels increased with increasing body weights, same as Pb in Vinsan station. However comparison between condition index and metal levels for Zn and Pb showed that metal concentrations were inversely related to the condition index. A previous study has reported that for metals, tissue concentration is inversely proportional to the condition index [4]. For this reason correlation graphics were plotted CI versus concentrations for Zn and Pb and dry weight versus concentrations for Mn and Fe (Fig. 2). In general metal concentrations were higher than those observed in other locations of the Marmara Sea [3]. These results represent the first CI and metal concentration data from the region in the framework of a monitoring project in the Izmit Bay. Further researches are necessary to understand the relationship between metal accumulation and body size of mussels more clearly in the region.

Acknowledgements

This study was funded by TUBITAK (Grant No: 107Y261) and Kocaeli University (Grant No: 2008/017).

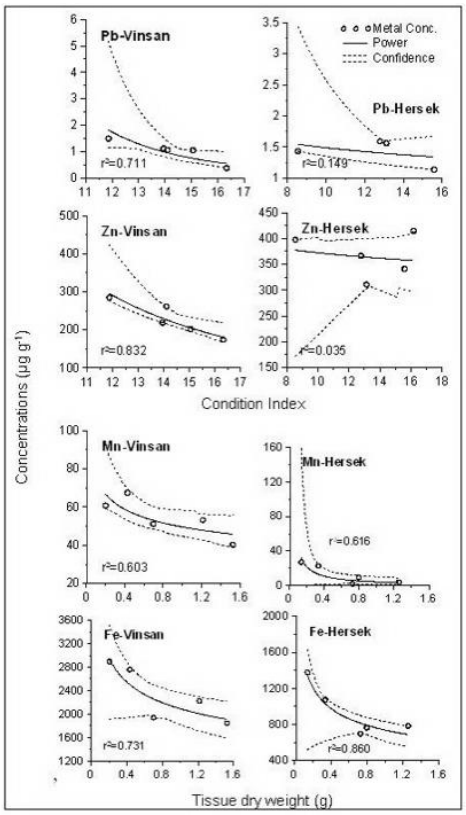


Fig. 2. Heavy metal concentration in mussels in Izmit Bay.

References

1 - Riget, F., Johansen, P., Asmund, G., 1996. Influence of length on element concentrations in blue mussels Mytilus edulis. *Mar. Pollut. Bull*. 32, 745e751.

2 - Saavedra, Y., Gonza´lez, A., Ferna´ndez, P., Blanco J., 2004. The effect of size on trace metal levels in raft cultivated mussels (*Mytilus galloprovincialis*) *The Science of the Total Environment* 318 (2004) 115–124.

3 - Topcuoglu, S., Kirbasoglu, Ç., Yilmaz,Y.Z. 2004. Heavy metal levels in biota and sediment samples in the northern coast of the Marmara Sea. *Environ.Monit.Assess*., 96,183-189.

4 - Andral, B., Stanisiere, J.Y., Sauzade, D., Damier, E., Thebault, H,. Galgani, F., Boissery, P., 2004. Monitoring chemical contamination levels in the Mediterranean based on the use of mussel caging, *Marine Pollution Bulletin* 49 704–712.

PAH/PCB CONCENTRATIONS IN MUSSELS (*MYTILUS GALLOPROVINCIALIS*) FROM IZMIT BAY

H. Ergül [1], B. Pekey [2]*, A. Karademir [2], B. Telli [1], M. Terzi [1] and Ü. Ay [3]
[1] Kocaeli University Science and Art Faculty Department of Biology, Kocaeli, Turkey
[2] Kocaeli University Engineering Faculty Department of Environmental Engineering - bpekey@kocaeli.edu.tr
[3] Kocaeli University Science and Art Faculty Department of Chemistry

Abstract
PAH and PCB concentrations were determined in mussel samples collected from Izmit Bay at the east of marmara Sea. The samples were taken from ten points in spring season and analyzed by gas chromatography after ultrasonic extraction. Total PAH concentrations varied between 2.5-13.9 ng.g-[1] wet wt., while the total PCB concentrations were between 4.2-140.7 ng.g-[1] wet wt. The results indicates a considerable pollution problem in the bay, especially with respect to PCBs.
Keywords: Pah, Pcb, Bivalves, Marmara Sea

Introduction
Izmit Bay, located in Northeastern Marmara Sea, has strongly been affected by growing populations and industrialization since 1960s. The study presents the first results of PAH/PCB analyses in the mussel samples in the framework of a pollution monitoring project in Izmit Bay.

Materials and Methods
Mussel samples were taken from ten different points in Izmit Bay in spring season (April 2008). Ultrasonic extraction was used to extract the PAHs and PCBs from the mussels samples. At least 30 mussels were dissected and soft parts selected for analysis. The samples were cleaned up on an alumina–silicic acid column containing 3 g of silicic acid (deactivated with 3% water) and 2 g of alumina (deactivated with 6% water). After treatment with sulfuric acid, the final sample volume was adjusted to 1 ml by nitrogen blow-down. The two fractions containing PAHs and PCBs were analyzed using a Hewlett-Packard 7890 gas chromatograph equipped with an flame ionization detector (for PAHs) and an electron capture detector (for PCBs).

Results and Discussions
Results were summarized in Fig. 1-2.

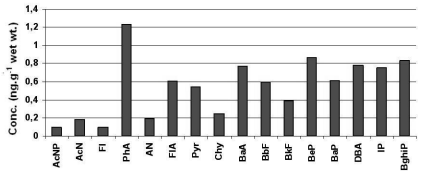


Fig. 1. Average PAH concentrations in mussels.

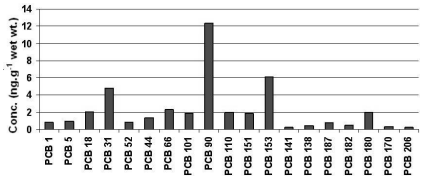


Fig. 2. Average PCB concentrations in mussels

Mean mussel shell length were determined 5.26 cm among ten stations. Total PAH concentrations varied between 2.5-13.9 ng.g^{-1} wet wt., with the average of 8.8 ng.g^{-1} wet wt. Relatively dominant PAH compounds were found as phenanthrene, benzo(e)pyrene and benzo(ghi)perylene. The mussel PAH levels were generally similar (higher than 7 ng.g^{-1} wet wt.) for the sampling points, with the exception of two points located on the north side of the Bay (with PAH levels about 2-3 ng.g^{-1} wet wt.). These results are interesting, because these two points are close to the refinery and other possible PAH sources. This may be attributed to the effect of water circulation patterns in the Bay, as given in a previous study [1]. On the other hand, observed PAH concentrations are in the range of the levels obtained in the mussels from similar polluted water bodies [2].
Total PCB levels, on the other hand, were between 4.2-140.7 ng.g^{-1} wet wt., producing an average of 42.1 ng.g^{-1} wet w. For PCBs, PCB 90, PCB 153 and PCB 31 were the dominant congeners. The highest PCB levels were observed in the points on north and east side of the Bay, suggesting a clear effect of industrial discharges. Mussel PCB levels were relatively high as compared to other studies conducted in Izmit Bay and Marmara Sea [1, 3].
A general evaluation of total PAH/PCB data from all the stations indicates that the pollution levels are considerably high not only at the points close to possible sources, but also the points away from these sources, possibly due to the effects of oceanographic and meteorological factors.

Acknowledgements : This study was funded by TUBITAK (Grant No: 107Y261) and Kocaeli University (Grant No: 2008/017).

References
1 - Telli-Karakoç, F., Tolun, L., Henkelmann, B., Klimm, C., Okay, O., Schramm, K. W., 2002. Polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) distributions in the Bay of Marmara sea: Izmit Bay. *Environ Pol.* 119:383-397.
2 - Namiesnik, J., Moncheva, S., Park, Y.S., Ham, K.S., Heo, B.G., Tashma, Z., Katrich, E., Gorinstein, S., 2008. Concentration of bioactive compounds in mussels Mytilus galloprovincialis as an indicator of pollution. *Chemosphere*, 73: 938-944.
3 - Okay, O., Karacik,B., Basak, S., Henkelmann, B., Bernhöft, S., Schramm, K. W., 2009. PCB and PCDD/F in sediments and mussels of the Istanbul strait (Turkey). *Chemosphere*, 76: 159-166.

ASSESSMENT OF THE BIOGEOCHEMICAL PARAMETERS IN NEMRUT BAY AEGEAN SEA

Esin Esen [1]*
[1] Dr. - esinsn@gmail.com

Abstract
The biogeochemical properties of the water column in Nemrut Bay showed that the anthropogenic influence is mostly detected in stations closer to the shoreline. The heavy metal content of the sediment revealed that the contaminant levels for most of the trace elements were heavily polluted throughout the Bay.
Keywords: Metals, Nutrients, Pollution, Coastal Waters, Aegean Sea

Introduction
Aliaga town located 50 km northwest of Izmir Municipality has been subjected to extensive industrial developments. Nemrut Bay, neighboring marine environment of Aliaga town was investigated to provide baseline information about the environmental conditions within the framework of an environmental impact assessment of a proposed Zinc Recovery Plant which aims to recover zinc oxide from waste material produced in the Aliaga Heavy Industrial Zone [1]. Nemrut Bay is a subsystem within the Candarli Bay ecosystem and opens up to the Aegean Sea.

Material and Methods
Field measurements were carried out by RV/K. Piri Reis during 2005. Seawater samples were collected from three depths in 15 stations. Dissolved oxygen was recorded *in situ*. Nutrient and total organic carbon analyses have been carried out according to the methods presented in [2]. Metal measurements were carried out in AAS using flame, graphite furnace and cold vapor techniques. Particulate phosphate (PP) contents were measured by the spectrophotometric method where the particulate organic carbon and particulate organic nitrogen contents were analyzed at CHN analyzer.

Results and Discussions
Nutrients : Dissolved oxygen values for July sampling varied between 6.29-7.20 mg/l that were found to be lower than the values measured for February sampling (7.50-8.28 mg/l). Nitrate and nitrite concentrations of Nemrut Bay were below the typical values determined in coastal waters in both periods (0.09-2.90, 0.01-0.29 µM respectively). High ammonium and ortho phosphate concentrations were measured in February along coastal stations of the Bay (0.5-9.9, 0.1-4.6 µM) where the same parameters varied between 0.2-1.6 µM and 0.03-0.09 µM, respectively in July. The values of chlorophyll-a varied from 0.07 to0.24 µg/l in February and between 0.01-0.15 µg/l in July. The results show similarity to those of the Aegean Sea. In winter season, the deacrease in primary production caused less consumption thus high values of nutrients in February were determined. In summer season, the primary production increased so that the nutrients were depleted.
Heavy Metals : The heavy metal content of the water column have been determined for February and September. Hg, Cd, Pb, Cu, Zn, Mn and Fe concentrations are below the unpolluted seawater levels (0.001-0.018; 0.001-0.0025; 0.8-2.8; 0.27-3.1; 2.1-5.8; 0.5-1.9; 3.3-7.7 µg/l, respectively). Cr and Ni concentrations ranged 0.69-1.2 µg/l and 1.1-1.8 µg/l respectively and determined to be higher than typical seawater levels. The heavy metal content of the sediments in Nemrut Bay have been determined in February. Contamination Factors (CF) calculated for Nemrut Bay indicated that Pb and As had very high contamination levels where there were considerable Zn contamination in most of the sediment samples [3]. Hg concentrations that were measured in this study correspond to very high contamination and should be investigated in further studies (CF ranged 32.3-395 corresponding to a concentration range of 1.70-9.60 mg/kg). The elevated enrichment levels of Pb (2.03-16.06) and Zn (1.08-8.52) indicates anthropogenic pollution.
PAH and Phenols in Surface Water : Polycyclic aromatic hydrocarbon (PAH) and phenol concentrations were measured from surface water samples. The results indicated that there were no PAH and phenol pollution for the sampling area and the sampling period.

Conclusion
The biogeochemical properties of the water column in Nemrut Bay showed that the anthropogenic influence is mostly detected in stations closer to the shoreline.

Acknowledgements This study is financed by ZincOx Plc. Inc. The author thank to the staff of RV Piri Reis and IMST for sampling and analysis.

References
1 - IMST-160 Feasibility Study on Marine Discharge of the effluents of Aliaga Zinc Recovery Plant
2 - Methods of Seawater Analysis, 1983, Second, Revised and Extended Edition, Edited by K. Grasshoff, M. Ehrhardt, K. Kremling, Verlag Chemie, 419p.
3 - Esen E., F. Küçüksezgin, E. Uluturhan., 2008."Assessment of trace metal pollution in surface sediments of Nemrut Bay, Aegean Sea", *Environ Monit Assess*, DOI 10.1007/s10661-008-0692-9.

SUSPENDED SEDIMENT AND ASSOCIATED RADIONUCLIDES TRANSPORT : 2001-2008 FLOOD MONITORING AT THE LOWER RHÔNE RIVER

F. Eyrolle [1]*, P. Raimbault [2], C. Antonelli [1], E. Ferrand [1], D. Aubert [3] and O. Radakovitch [4]

[1] LERCM, Institut de Radioprotection et de Sûreté Nucléaire - Centre de Cadarache, BP 3, 13115 Saint Paul Lez Durance, France - frederique.eyrolle@irsn.fr

[2] CEFREM, Université de Perpignan Via Domitia CNRS UMR 5110, 52, av Paul Alduy, 66860 Perpignan, France

[3] CEREGE, Université d'Aix-Marseille CNRS UMR 6635; Europôle Méditerranéen de L'Arbois, BP 80, 13545 Aix en Provence, France

[4] LMGEM, – COM case 901, 163 avenue de Luminy, 13288 MARSEILLE Cedex 9, France

Abstract

Total Suspended Solid loads (TSS) and associated natural and artificial radionuclides were monitored over the 2001-2008 period at the lower course of the Rhône River thanks to the SORA monitoring station located at Arles. The high frequency monitoring established affords to quantify TSS annual fluxes and TSS fluxes generated by flood events. Besides, the survey allowed registering two uncommonly high loaded events in 2008 partly due to dam management. 9.1 106 tons were thus exported in 2008 whose almost 70% during the two atypical events of may and December. Globally, artificial and natural radionuclide activities display a decreasing trend with rising liquid flow rates making possible to access to geochemical or anthropogenic background values.

Keywords: Radionuclides, Monitoring, Rhone Delta

As described for many land to sea systems, the Rhône River inputs affect primary production significantly in the north-western Mediterranean area and plays a leading role on the marine ecosystem functioning in the whole Gulf of Lion [1]. The Rhône River also transfers to the Sea various Potentially Contaminating Trace Elements (PCTE) including heavy metals, poly-aromatic hydrocarbon and artificial radionuclides that are largely associated to solid compounds, i.e. particles. Radionuclides inputs from the Rhône River whatever from natural or artificial origin may generate radiotoxicity for man and its environment even though generally awfully low due to the extremely low level of contamination. The inputs of particle reactive radionuclides from the Rhône may be also of a particular interest to determine residence time of sedimentary mass from the coastal to the open sea. In this frame depending on the distance to the source term, i.e. the Rhône mouth, and the velocity of mass transfers, short to long-lived radionuclides may represent useful tools for quantifying sedimentary mass dynamics at various spatial scales. In this frame, Total suspended sediment (TSS) and associated natural and artificial radionuclides were monitored over the 2001-2008 period at the lower course of the Rhône River. Over this period of time high frequency samplings was gradually established for floods > 3000 $m^3.s^{-1}$ as these events were shown to export the main part of the solid load towards the marine environment [2-5]. Our results underline several key points:

a- TSS loads follow a power function relationship with the liquid discharge that does not significantly differ from the relations established for previous period of time. The correlation is highly significant mainly due to the huge number of data Nevertheless, TTS concentrations may range over two to three orders of magnitude for a same liquid flow rate in some cases.

b- From 2001 to 2008 TSS annual fluxes ranged from 0.98 10^6 tons in 2005 to 9.1 10^6 tons in 2008, with a mean value of 4.7 10^6 tons.

c- Dam management during flood episodes and consecutive excess water and sediment deliveries may conduct to 'semi anthropogenic floods' characterised by moderated liquid discharges but abnormally high TSS concentrations. In 2008, 56% of the solid annual flux was transferred during such an event. The high frequency TSS survey at the lower course of the Rhône made possible to register for a first time such scare unusually heavy loaded floods that may largely supply solid fluxes to the sea.

d- The particulate concentrations of the various studied radionuclides show generallly a decreasing trend with rising liquid discharges towards more or less constant values reflecting the geochemical or anthropogenic background levels.

e- ^{238}Pu and $^{239+240}Pu$ isotopes display a different trend as increasing particulate activities have been registered during rising waters due to the remobilisation of labelled sedimentary storages downstream of the Marcoule spent fuel reprocessing plant. Around 30% to 50 % of $^{239+240}Pu$ and 80% to 90% of ^{238}Pu transferred by the River downstream during flood events originate from sediment remobilisation, the residual coming from the soil erosion of the watershed.

f- $^{238}Pu/^{239+240}Pu$ activity ratio signatures during Rhône River floods may present an important variability (1) over a single flood event since hysteresis loops were observed and (2) between two different events depending on flood types and probably on the flood chronicles.

References

1 - Raimbault, P., Durrieu de Madron, X., 2003, Research activities in the Gulf of Lion (NW Mediterranean) within the 1997-2001 PNEC project. *Oceanologica Acta*, 26, 291-299.

2 - Rolland B., C. Antonelli and F. Eyrolle, 2004, Fluxes of suspended material and associated radionuclides to the sea during flood events of the Rhône River, Proceedings of the ECORAD 2004 international symposium, 6-10 sept. 2004, Aix en Provence, France, P3, 35.

3 - Rolland B., 2006, Transfert des radionucléides artificiels par voie fluviale : conséquences sur les stocks sédimentaires rhodaniens et les exports vers la Méditerranée. Thèse, Université Paul Cézanne d'Aix-Marseille, 243 p.

4 - Radakovitch O., Roussiez V., Ollivier P., Ludwig W., Grenz C., Probst J.L., 2007, Input of particulate heavy metals from rivers and associated sedimentary deposits on the Gulf of Lion continental shelf. *Estuarine, Coastal and Shelf Science*, 77, 2, 285-295.

5 - Antonelli C., Eyrolle F., Rolland B., Provansal M., Sabatier F., 2008, Suspended sediment and 137Cs fluxes during the exceptional December 2003 flood in the Rhone River, southeast France. *Geomorphology*, 95, 3-4, 350-360.

DIETARY SOURCES DOMINATE METAL UPTAKE IN MARINE FISH

Nicholas Fisher [1]*, Teresa Mathews [1] and Jessica Dutton [1]
[1] Stony Brook University, Stony Brook, NY USA - nfisher@notes.cc.sunysb.edu

Abstract
The bioaccumulation of 10 metals in five fish species was experimentally evaluated following exposure to dietary or aqueous metal at environmentally realistic metal concentrations. A biokinetic model showed that, with few exceptions, >90% of a fish's metal body burden was obtained from diet. Regulatory bodies need to consider these findings in setting appropriate water quality criteria. Metal uptake from the aqueous phase was influenced by dissolved organic carbon and salinity, but no consistent patterns were evident for all metals.
Keywords: Bio-Accumulation, Fishes, Models, Metals

Like other aquatic animals, fish can acquire contaminants, including potentially toxic metals, from their diet and from the surrounding water [1]. Most water quality criteria for regulatory purposes are based on aqueous concentrations, as are most standard toxicity tests. However, because metals are concentrated in the food that fish eat by hundreds to thousands of times over levels in the ambient water [2], the dietary sources commonly represent especially enriched sources of metals. Here we present results of experimental studies in which diverse fish from coastal and estuarine environments were exposed to metals from both water and from their diet to assess the relative importance of these sources. We quantified uptake rate constants from the dissolved phase for diverse metals and assimilation efficiencies from ingested food, and determined the release rates of metals following different exposure pathways. We then used these kinetic parameters in a metal bioaccumulation model to compare the relative importance of diet and aqueous exposures as sources of metals for fish.

We used gamma-emitting radioisotopes to determine the uptake, retention, and tissue distribution of Am, As, Cd, Co, Cs, Hg, monomethylmercury (MeHg), Mn, Se, and Zn in four teleosts (*Fundulus heteroclitus*, *Sparus auratus*, *Menidia menidia*, *Psetta maxima*) and one elasmobranch (*Scyliorhinus canicula*) exposed to these metals either from their food or the dissolved phase. The diets consisted of either worms, amphipods, brine shrimp nauplii, or juvenile fish. We also evaluated the influence of dissolved organic carbon (DOC) and salinity on the uptake of metals from the aqueous phase in the euryhaline *F. heteroclitus*, which is used as a bioindicator organism of coastal contamination. Assimilation efficiencies (AEs) from diet were determined using pulse-chase methodology [3]. A biokinetic model [4] to assess metal bioaccumulation describes metal concentrations in fish, at steady state (C_{ss}), as: $C_{ss} = [(k_u \times C_w)/(k_{ew} + g)] + [(AE \times IR \times C_f)/(k_{ef} + g)]$, where k_u = uptake rate constant from the aqueous phase, C_w = dissolved metal concentration, AE = assimilation efficiency of ingested metal, IR = weight-specific ingestion rate, C_f = metal concentration in food, k_{ew} and k_{ef} = efflux rate constants of metals following aqueous and dietary uptake, respectively, and g = growth rate constant (Wang et al. 1996). This model evaluated the relative importance of diet and aqueous phases as sources of metal for these fish. For modeling, values for AE, k_u, k_{ew}, and kef were determined experimentally, whereas C_w, C_f, IR and g were taken from the literature [5,6]. Metal uptake was predominantly from dietary sources for most metals and fish species (Table 1). DOC concentrations were generally inversely related to Cr, Hg, and MeHg uptake and positively related to As uptake from the aqueous phase [8]. Salinity, over a range of 0 -20 psu, was inversely related to uptake of Cd and positively related to uptake of As, Hg, and MeHg [8]. Although uptake of metals from the aqueous phase is not negligible in marine fish, clearly dietary sources predominate (Table 1), and must be considered in setting appropriate water quality criteria for coastal regions.

Tab. 1. Model-estimated per cent of metal body burden calculated for diverse metals in 5 fish species feeding on crustaceans using measured kinetic parameters [3, 6-8]. Model predictions assumed that g was negligible compared to k_e values and assumed a mean IR value = 0.05 g g^{-1} d^{-1}. nd = not determined.

Metal	*S. canicula*	*P. maxima*	*S. auratus*	*M. menidia*	*F. heteroclitus*
Am	<1	43	91	nd	nd
As	nd	nd	nd	nd	12
Cd	>99	>99	>99	>99	35
Co	98	99	>99	nd	nd
Cs	97	86	78	nd	nd
Hg	nd	nd	nd	>99	69
MeHg	nd	nd	nd	98	>99
Mn	>99	99	>99	nd	nd
Se	nd	nd	>99	>99	nd
Zn	>99	>99	>99	>99	nd

References
1 - Luoma, S.N. and Rainbow, P.S., 2005. Why is metal bioaccumulation so variable? Biodynamics as a unifying concept. *Environ. Sci. Technol.*, 39: 1921-1931.
2 - IAEA, 2004. Sediment distribution coefficients and concentration factors for biota in the marine environment. Tech. Rept. Ser. 422, Vienna.
3 - Mathews, T. and Fisher, N.S., 2008. Trophic transfer of seven trace metals in a four-step marine food chain. *Mar. Ecol. Prog. Ser.*, 367: 23-33.
4 - Wang, W.X., Fisher, N.S., and Luoma, S.N., 1996. Kinetic determinations of trace element bioaccumulation in the mussel *Mytilus edulis*. *Mar. Ecol. Prog. Ser.*, 140: 91-113.
5 - Kennish, M.J., 1997. Practical Handbook of Estuarine and Marine Pollution. CRC Press, Boca Raton.
6 - Mathews, T. and Fisher, N.S., 2009. Dominance of dietary intake of metals in marine elasmobranch and teleost fish. *Sci. Total Environ.*, 407: 51556-5161.
7 - Mathews, T., Fisher, N.S., Jeffree, R.A., and Teyssie, J.L., 2008. Assimilation and retention of metals in teleost and elasmobranch fishes following dietary exposure. *Mar. Ecol. Prog. Ser.*, 360: 1-12.
8 - Dutton, J. and Fisher, N.S., unpublished results.

ORGANOTIN CONTAMINATION IN THE COASTAL ZONE OF THE EASTERN ADRIATIC (SIBENIK AREA)

M. Furdek [1]*, M. Vahcic [2], T. Zuliani [2], N. Mikac [1] and J. Scancar [2]
[1] Ruder Boskovic Institute - mfurdek@irb.hr
[2] Jozef Stefan Institute

Abstract

Organotin compounds (OTC) were measured with two different analytical methods in sediment, mussels and seawater from the central part of the eastern Adriatic coast. Butyltin compounds were found in all analyzed samples, with the highest concentrations obtained in samples from the several investigated marinas. These results indicate that TBT is still in use in Croatia and that coastal area is contaminated with these highly toxic compounds.

Keywords: Adriatic Sea, Sediments, Pollution, Monitoring, Bivalves

Introduction

The extensive use of tributyltin (TBT) compounds in ship antifouling paints over last four decades has created a global pollution problem. The widespread use of organotin compounds (OTC) started in 1950s and already in 1970s the negative effects of TBT on marine organisms were discovered. TBT containing antifouling paints were banned first on the ships less than 25 m and from January 2008 the use of TBT is banned in EU countries. The use of TBT in antifouling paints in Croatia is still not regulated by legislative.

In addition, there is no data on the level of OTC in samples from the Croatian Adriatic coast. However, a high degree of imposex (widely used as a biomonitoring tool of TBT contamination), found in gastropoda *H. trunculus* from the eastern Adriatic coast in 2005 [1], suggested that Croatian coats might be highly contaminated with TBT. Here we present first data on the level of OTC (methyl, buthyl, octyl and phenyl species) in samples from the central Adriatic.

Sampling and methods

Samples for organotin analysis were collected at 7 coastal locations in the Sibenik area, central part of the Croatian Adriatic coast, in Septemper 2009. Sampling locations included 5 marinas (RO-Rogoznica; MN-Mandalina; SL-Solaris, SK-Skradin; V-Vodice), Sibenik port (L-Luka) and one referent station in the Sibenik channel (MA-Martinska) which is not heavily exposed to the ship traffic. At every location sediment cores, mussels and seawater were collected. Analysis of organotin compounds were performed with two different analytical techniques, GC-PFPD (Gas Chromatography Pulse Flame Photometric Detection) and GC-ICPMS (Gas Chromatography Inductively Coupled Plasma Mass Spectrometry).

Results and discussion

Distributions of butyltin compounds (MBT-monobutyl; DBT-dibutyl; TBT-tributyl) in surface sediment, mussels and seawater at 7 sampling locations are presented in Fig. 1. Significant levels of all butyltin compounds are found at all sampling locations, especially in marinas Mandalina (MN) and Rogoznica (RO). The concentration levels in sediment and mussels are comparable with the ones determined in samples from the Slovenian coast in 2002 [2] and indicate that TBT is still in use in Croatia. TBT derivatives prevail in sediment and mussels which also suggests recent input of TBT into marine environment. More abundant concentration of DBT than TBT in water reflects instability of TBT in water and fast decomposition into lower butyl derivatives. At all location except referent one (Martinska), level of DBT in seawater was higher than 0,2 ng/l, which is permitted level of individual butyltin derivatives in water defined by Croatian and European regulative. Total concentration of butyltin compounds in analyzed sediment cores decreases with depth and DBT and MBT prevail in deeper sediment layers, both indicating TBT decomposition in sediment with time. From other butyltin compounds traces of some methyl and octyl derivatives are found in water and mussels.

Acknowledgement: Financial support from the Ministries of sciences of Croatia and Slovenia by the bilateral project BI-HR/09-10-025 is acknowledged.

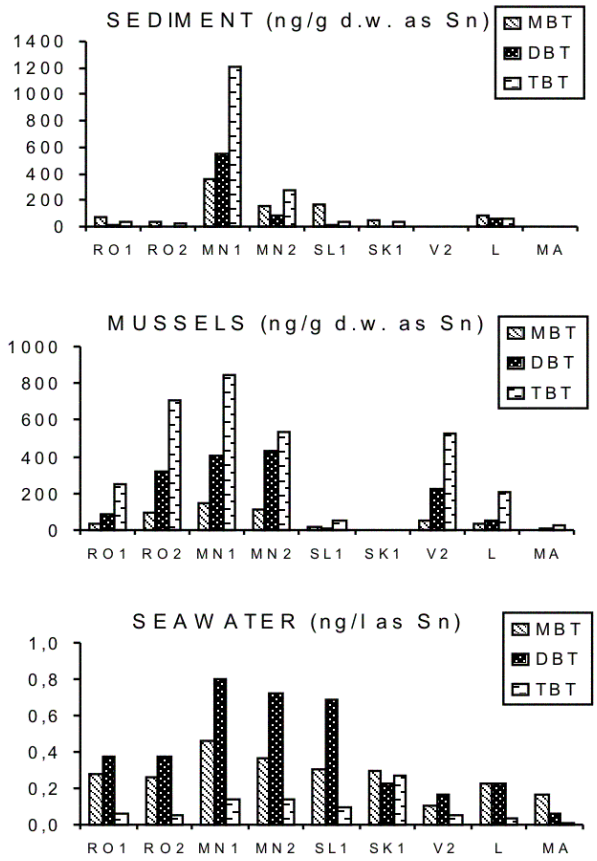


Fig. 1. Distribution of butyltin compounds in surface sediment, mussels and seawater from the Šibenik area (eastern Adriatic coast).

References

1 - Šcancar, J., Zuliani, T., Turk T., Milacic R., 2007. Organotin compounds and selected metals in the marine environment of Northern Adriatic sea. *Environ. Monit. Assess.* 127: 271-282.

2 - Prime, M., Peharda, M., Jelic, K., Mladineo, I., Richardson, C.A., 2006. The occurrence of imposex in Hexaplex trunculus from the Croatian Coast, *Mar. Pollut. Bull.* 52: 800-815.

TRACE METAL DYNAMICS IN THE STRATIFIED KRKA RIVER ESTUARY (CROATIA): AN INTEGRATED APPROACH BY VOLTAMMETRY, DGT AND FLUORESCENCE SPECTROSCOPY

C. Garnier [1]*, D. Omanovic [2], A. Blataric [2], H. Zhao [1], V. Lenoble [1], N. Cukrov [2], J. Gonzalez [3], S. Mounier [1] and I. Pižeta [2]

[1] Laboratoire PROTEE, Université du Sud Toulon Var, BP20132, 83957 La Garde, France - cgarnier@univ-tln.fr

[2] Division for Marine and Environmental Research, Ruder Boškovic Institute, Bijenicka 54, 10000 Zagreb, Croatia

[3] IFREMER, Département Biogéochimie et Ecotoxicologie, B.P.330 Zone Portuaire de Brégaillon, 83507 La Seyne/mer cedex, France

Abstract

Trace metal dynamics in the stratified Krka River estuary (Šibenik bay, Croatia) has been studied by combination of different analytical and modelling tools for sampling campaigns 2007-2009. Results showed an increased metal content at the estuary surface layer in summer, especially for Cu due to antifouling paint release associated to strong boat traffic. Contrary to March-April period for which the organic ligands are sufficient to maintain the free Cu concentration at non-toxic level in the whole water column, in summer this limit is over-passed in the surface layer for at least one order of magnitude, particularly at locations close to nautical marina.

Keywords: Analytical Methods, Chemical Speciation, Estuaries, Metals, Organic Matter

Experimental

The Krka River estuary water column is permanently stratified because of a sheltered geography and the low tidal range of the Adriatic Sea. Due to low anthropogenic activities, this estuary is oligotrophic with ultratrace levels of heavy metals. However, during summer touristic period, the total Cu concentration increases, mainly because of Cu leaching from the antifouling paints [1]. According to depth variations of physico-chemical parameters ($T/S/pH/\%O_2$), samples were collected by scuba diving in April-2007 and March-2008, at 4 depths in front of the scientific marine station Martinska (site M). Additionally, in March-2008, samples were collected in the Krka River and the Adriatic Sea to obtain the 2 end-members of the estuarine water mixing. These samples were studied to (1) characterize the dissolved organic matter (DOM) by dissolved organic carbon (DOC) content and 3-D fluorescence spectroscopy (with PARAFAC analysis), (2) determine the dissolved metal concentrations by DPASV, and (3) study the DOM/Cu interactions by logarithmic titration with analysis of the ASV-labile Cu fraction and further modelling to define the DOM binding parameters by the classical at-equilibrium approach and by an innovative kinetic approach [2]. Furthermore, 2 field campaigns were performed in July-2008 and 2009. Diffusive- and restrictive-DGT were deployed during 3-4 days at 6 depths (according to physico-chemical parameters depth variation), at 2 distinctive sites: the "clean" site M, and a "polluted" one in a nautical marina (site S). DGT-labile metal levels were determined by HR-ICP-MS. In addition, water samples were collected 1-2 a day at each DGT-depth, leading to discrete and composite samples analysed for DOM, total/dissolved metal and DOM/Cu interactions by the previously described techniques.

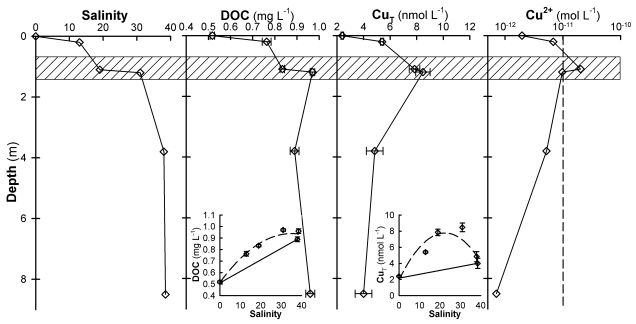


Fig. 1. Salinity, DOC, total dissolved Cu and calculated free Cu concentration depth profiles of samples taken in 2008; marked area represents the depth range of fresh/marine water interface. Vertical dashed line: the Cu toxicity limit of 10 pM [3]. Insets: Same parameters in relation to salinity; Full and dashed lines represent conservative and parabolic variations, respectively.

Results and discussion

DOC and Cu concentrations measured in April-2007 and March-2008 showed non-conservative variations, with a clear enhancement at the fresh/marine water interface (Fig.1). The main source of fluorescent material in the estuary is due to terrestrial inputs, and the additional OM produced by biological activities did not show any specific fluorescent signature. The increasing Cu concentration at the freshwater/seawater interface seemed to be controlled by the organic ligands (probably produced by biological activity), leading to calculated free-Cu concentrations lower than the toxicity limit of 10^{-11} M [3] (Fig.1). Our results validated the applicability/reliability of the kinetic approach in the determination of apparent stability constants and ligand concentrations, and additionally allowed the calculation of the association/dissociation rate constants, i.e. the dynamic of DOM/Cu interactions. In summer, important metal contamination of the estuary surface has been recorded, due to increasing boat traffic [1]. Under such conditions, predicted free-Cu concentrations over-passed the toxicity level in the whole water column, except at the bottom. Results obtained for the summer campaigns demonstrated that site S is more polluted than site M for Cd, Cu, Pb and Zn, but showed quite comparable values for Co, Cr, Mo, Ni and U (partly seen in Fig.2). Exception is for Mn which presented higher concentrations for site M, due to the vicinity of a former ferromanganese factory. Metal speciation could be directly determined by comparing DGT (diffusive/restrictive) and total/dissolved metal concentration profiles (Fig.2). Additionally, the binding parameters determined by the study of DOM/metal interactions allowed a more detailed definition of the metal speciation and the prediction of metal behaviour in different physico-chemical conditions.

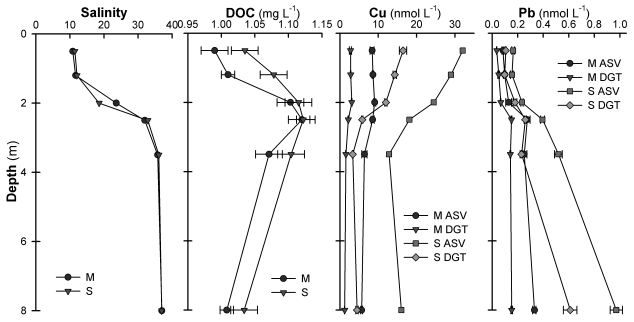


Fig. 2. Salinity, DOC, total dissolved Cu and Pb (by DPASV) concentration depth profiles of composite samples taken in 2009 and diffusive DGT-labile Cu and Pb concentrations depth profiles at both sampling sites

References

1 - Omanovic, D., Kwokal, Ž., Goodwin, A., Lawrence, A., Banks, C.E., Compton, R.G. and Komorsky-Lovric, Š., 2006. Trace metal detection in Šibenik bay, Croatia: Cadmium, lead and copper with anodic stripping voltammetry and manganese via sonoelectrochemistry. A case Study. *J. Iranian Chem. Soc.*, 3: 128–139.

2 - Louis, Y., Garnier, C., Lenoble, V., Mounier, S., Cukrov, N., Omanovic, D. and Pižeta, I., 2009. Kinetic and equilibrium studies of copper-dissolved organic matter complexation in water column of the stratified Krka River estuary (Croatia), *Mar. Chem.*, 114: 110-119.

3 - Sunda, W.G., Tester, P.A., Huntsman, S.A.,1987. Effects of cupric and zinc ion activities on the survival and reproduction of marine copepods. *Mar. Biol.*, 94: 203–210.

THE D-EXCESS AS A CHARACTERISTIC OF THE MEDITERRANEAN PRECIPITATION: A CRITICAL REVIEW

Joel Robert Gat [1]*

[1] Dpt. of Environmental Sciences and Energy Research; Weizmann Institute of Science - joel.gat@weizmann.ac.il

Abstract

A value of the d-excess larger than 15‰ in atmospheric waters of the Mediterranean region has been attributed to the special air-sea interaction mode on the continental leeside and has been utilized as a characteristic identifying moisture originating from the Mediterranean. This review examines additional factors affecting the d-excess parameter and points to the importance of also considering the in-cloud processes and vertical motions and exchange of the air masses over the sea in this context.

Keywords: Air-Sea Interactions, Atmospheric Input

Introduction

Following the recognition of elevated d-excess values in precipitation in the eastern Mediterranean Sea area and in adjacent marginal seas (such as the Adriatic,Black and Aegean seas) ([1], [2], [3]), this was attributed primarily to the large humidity deficit in the atmospheric waters on the leeside of the continent relative to the saturated vapour pressure at the sea surface, based on the Craig-Gordon Evaporation Model. This characteristic has been widely used to identify the contribution of the Mediterranean moisture source to precipitation in the region (e.g.[4]] and its paleoclimatic implications ([5],[6]).

Review of additional data sets of precipitation and atmospheric vapour:

Additional studies throughout the region, many of them as part of the IAEA sponsored CRP on the isotope composition of precipitation in the Mediterranean Basin [7], which included measurements of the isotopic composition of atmospheric vapour, suggested a strong dependence on the air mass trajectory into the area and on the seasonality [8]. These findings were generally in conformity with the basic premise of the Craig-Gordon model, but more detailed meteorological investigations [9], vapour measurements over the sea [10] and collection of orographic precipitation indicate that additional factors have to be taken into consideration before a reliable quantitative assessment can be made. Among them the changing isotope composition of the Mediterranean surface waters, addition of sea-spray and most notably, the non-equilibrium isotope fractionation in accompaniment of in-cloud and below cloud processes that occur en-route throughout the air column.

Model verification

Idealized model calculation of the isotopic composition of the evaporating flux (δ_E) for the range of expected values of the sea-water's isotope composition, of the atmospheric humidity parameters and temperature, all show a relative limited influence on the d-excess value of the resultant atmospheric moisture, beyond that predicted by the classical Craig-Gordon model. However the admixture of vapour that is the residue of non-equilibrium in-cloud and sub-cloud processes, as well as the vertical exchange processes over the ocean, are seen to perturb the isotopic signature of the atmospheric moisture significantly. These model predictions are going to be presented.

Conclusion

Due to the manifold factors contributing to the value of the d-excess in atmospheric waters, it is evident that a more detailed three-dimensional modeling of the air moisture's evolution throughout the region and its seasonal pattern is called for, augmented by appropriate vapour sampling and/or measurements.

References

1 - Gat J.R., 1969. The isotopic composition of atmospheric waters in the Mediterranean Sea area and their interpretation in terms of air-sea interaction. *Rapp.Comm.Int..Mer Medit.* 19,5: 923-926

2 - Dansgaard W. 1964. Stable isotopes in precipitation. *Tellus* 16: 436-468.

3 - Gat J.R. and Carmi I., 1970. Evolution of the isotopic composition of atmospheric waters in the Mediterranean Sea area. *J.Geophys.Res.* 75:3039-3045.

4 - Senturk F. et al., 1970. Isotope techniques applied to groundwater movement in the Konya plain. 1970. *IAEA Symposium on the use of isotopes in Hydrology*, paper SM129/11.

5 - Gat J.R. and Rindsberger M., 1985. The isotopic signature of precipitation originating in the Mediterranean sea area: A possible monitor of climate modification. *Israel Journal of Earth Sciences* 34: 80-85.

6 - Gat J.R. and Carmi I., 1987. Effect of climate changes on the precipitation patterns and isotopic composition of water in a climate transition zone: case of the eastern. In: *Influence of climate change and climate variability on the* IAHS 168: 513-523

7 - IAEA., 2005. Isotope composition of precipitation in the Mediterranean basin in relation to the circulation patterns and climate. *IAEA- tecdoc*1453

8 - Angert A., Lee J-E and Yakir D., 2008. Seasonal variations in the isotopic composition of near-surface water vapour in the eastern Mediterranean. *Tellus*, pp11.

9 - Pfahl S. and Wernli H. 2004. Air parcel trajectory analysis of stable isotopes in water vapour in the eastern Mediterranean. *J.Geophys.Res.*113: D20104.

10 - Gat J.R., Klein B., Kushnir Y., Roether W., Wernli H., Yam R. and Shemesh A., 2003. Isotope composition of air moisture over the Mediterranean Sea: an index of the air sea interaction pattern. *Tellus* 55B: 935-965.

BIOGEOCHEMICAL PROPERTIES OF ADRIATIC DENSE WATERS

M. Giani [1]*, V. Kovacevic [1], V. Cardin [1], B. Mihai [1], L. Ursella [1], F. Rampazzo [2], D. Berto [2], F. Savelli [2], G. Catalano [3], S. Cozzi [3], C. Cantoni [3] and A. Luchetta [3]

[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - mgiani@ogs.trieste.it

[2] Istituto Superiore per la Protezione e la Ricerca Ambientale-ISPRA; Chioggia, Italy

[3] Istituto di Scienze del Mare ISMAR-CNR, Trieste , Italy

Abstract

Distribution and characteristics of dense waters in the Adriatic Sea were monitored during their formation in winter 2008, and later, in autumn at the end of the seasonal stratification period in the Adriatic Sea. Different types of dense waters were identified on the basis of their physical features. In order to characterised their biogeochemical properties dissolved oxygen, nutrient, and particulate organic matter (chlorophyll a, particulate organic carbon, particulate nitrogen and phosphorus) were analysed.

Keywords: Adriatic Sea, Particulates, Oxygen, Nutrients, Organic Matter

The Adriatic Sea is one of the few sites in the Mediterranean Sea where dense waters are formed. This process represents an important driving engine for the circulation and ventilation of deep waters of the Eastern Mediterranean. Though the physical properties and mechanism of formation are well described [1], the biogeochemical features are known only for the dissolved inorganic nutrients [2]. Even less information is available for the particulate organic matter [3] and its relevance in the carbon cycling in the Mediterranean Sea. The whole Adriatic Sea system responds significantly to climatic variability, which acts on the properties of the water masses originating in the Adriatic, as well as on the exchange with the adjacent basins. The state of the art presented in this work derives from two cruises carried out in February and October 2008 in the framework of SESAME-EU-FP6 and VECTOR projects. During the winter season, cooling and evaporation triggered mixing leading to dense water formation over the northern shelf, and deep convection in the Southern Adriatic. The biogeochemical characteristics of these dense waters depend on the site and timing of preconditioning and formation. The North Adriatic Dense water (NAdDW) formed in winter flows southwards partly refilling the Middle Adriatic Pit increasing the oxygenation degree of those bottom waters and partly flowing into the Southern Adriatic Pit. The NAdDW is cooler and well oxygenated, especially if formed in late winter. In some years the maximum density (σ_θ) can reach more than 29.8 kg/m^3 [1], depending on frequency and intensity of northeasterly dry wind (Bora). In February 2008 maximum values observed in the northern Adriatic were 29.6 kg/m^3 for σ_θ (figure 1)

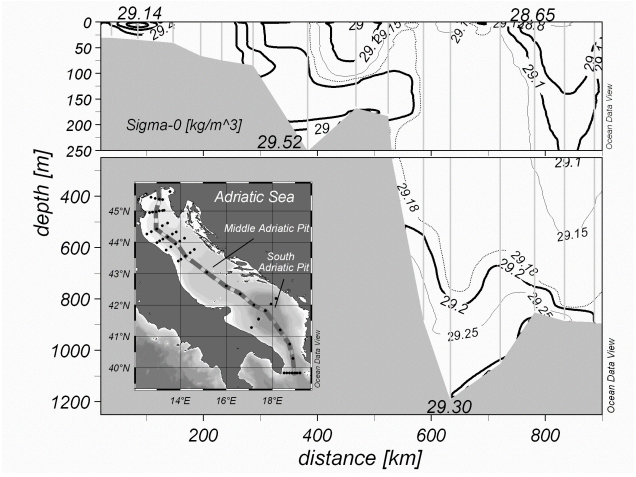


Fig. 1. Vertical distribution of density along the NW-SE longitudinal section of the Adriatic Sea.

and 106% for oxygen saturation (figure 2), indicating the beginning of primary production processes. They were richer in particulate organic carbon and nitrogen with respect to the other dense waters present in the basin during winter. The dense waters near the bottom of the Middle Adriatic Pit were oxygen depleted (figure 2) and had higher nutrient concentrations. The increase of oxygen saturation (from 65% to 75%) and the decrease of inorganic nutrient concentrations from February to October indicated the advection in the Middle Adriatic Pit of new dense waters.

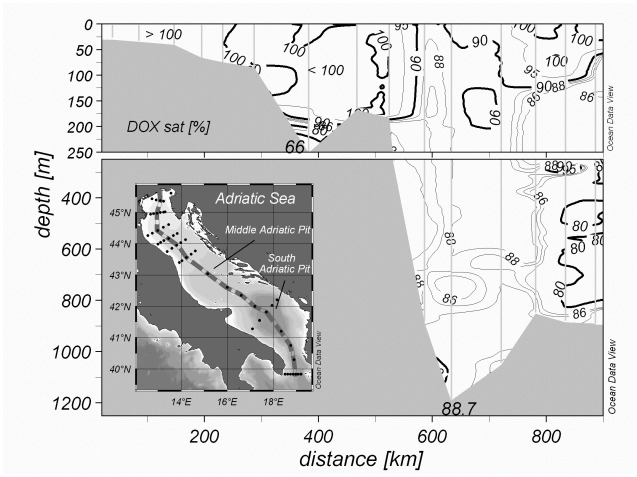


Fig. 2. Vertical distribution of dissolved oxygen along the NW-SE longitudinal section of the Adriatic Sea.

During this period the convection reached 700-800 meter depth in the Southern Adriatic (figure 1) bringing the nutrient rich undersaturated Levantine Intermediate Waters up to the surface, which just after the oceanographic cruise gave rise to a phytoplankton bloom within the Southern Adriatic cyclonic gyre, as observed from the chlorophyll-*a* distribution from MODIS AQUA satellite images. In autumn the SAdDW, which occupies the bottom of the Southern Adriatic Pit, got warmer, slightly less dense, more undersaturated than in winter. Contemporarily an increase in the concentrations of nutrients and suspended particulate matter took place due to the settling of particulate matter and degradation processes. The Adriatic Dense Water (ADW), is a mixture of deep waters formed in the Southern Adriatic, in the Northern and in the Middle Adriatic [1]. It flows out from the basin through the Strait of Otranto in depth along the western flank. The Ionian surface and Levantine Intermediate Waters flow into the Adriatic along the eastern flank. The ADW had similar concentration of suspended particulate matter both in February and October 2008. However, the saturation of dissolved oxygen decreased to 80% and the nutrient concentration increased in October 2008, due to the remineralization processes.

References

1 - Gacic M., Lascaratos A., Manca B.B. and Mantziafou A., 2001. Adriatic deep water and interaction with the Eastern Mediterranean Sea. *In*: Cushman-Roisin, B. *et al*.(eds.) Physical Oceanography of the Adriatic Sea, Kluwer Acadenic Publishers, pp 111-142.

2 - Zavateralli M., Raicich F., Bregant D., Russo A. and Artegiani A., 1998. Climatological biogeochemical characteristics of the Adriatic Sea. *Jour. Mar. Syst.*, 18: 227-263.

3 - Civitarese G., Gacic M., Vetrano A., Boldrin A., Bregant D., Rabitti S. and Souvermezoglou E., 1998. Biogeochemical fluxes through the Strait of Otranto (Eastern Mediterranean). *Cont. Shelf Res*., 18: 773-789.

ORGANIC GEOCHEMICAL PROXIES IN THE SEDIMENTARY RECORD OF THE E. MEDITERRANEAN SEA: PALEO-ENVIRONMENTAL AND -CLIMATIC RECONSTRUCTIONS DURING THE LAST 20,000 YRS

A. Gogou [1]*, G. Katsouras [1], I. Bouloubassi [2], M. Triantafyllou [3] and V. Lykousis [1]
[1] Hellenic Centre for Marine Research, Institute of Oceanography - agogou@ath.hcmr.gr
[2] LOCEAN, CNRS UMR 7159, Université P. et M. Curie, Paris, France
[3] University of Athens, Faculty of Geology & Geoenvironment, Dept. of Historical Geology-Paleontology, Athens, Greece

Abstract
Sedimentary organic matter (OM) provides a variety of proxies for the reconstruction of marine and continental paleoenvironments and paleoclimates. In this study, we compare biogeochemical proxies isolated from three sediment cores in the Eastern Mediterranean Sea (from the Aegean and Libyan Seas) during the last 20,000 yrs. The marginal Eastern Mediterranean Sea represents a 'natural laboratory' for paleoceanographic studies due to its sensitivity to oceanographic and climatological changes ([1], [2]).
Keywords: Aegean Sea, Eastern Mediterranean, Organic Matter, Paleoceanography, Sapropel

Early Holocene sediment records collected in the Eastern Mediterranean Sea (EMS) bear witnesses for the formation of the most recent sapropel S1, closely associated with distinct minima in the orbital precession cycle and the insolation-driven monsoon maxima ([3]). The different scenarios of S1 deposition involve changes in marine productivity, organic matter preservation and circulation changes and are still under debate ([4], [5], [6]). Herewith, we present a high-resolution study of organic geochemical proxies in three gravity cores collected from the EMS, namely the cores SL152 and NS-14 collected from the Aegean Sea (north and southeast, respectively), and core HCM2/22 collected from the Libyan Sea. Our goal is to investigate the patterns of organic matter accumulation and preservation and reconstruct paleo-SSTs based on alkenone unsaturation index Uk´37 during the last 20,000 yrs with focus on the deposition of sapropel S1 along a north-south transect in the EMS. Depending on the water column depth, the sediment accumulation rates and the proximity to freshwater and water formation sources, S1 deposited in our records between ~9.8 to 6.4 kyr BP, with an apparent interruption in the S1 deposition that occurred from ~8.6 to 7.6 kyr BP. At the Holocene climatic optimum, SSTs increase gradually more than 4°C and reaches values as high as 21.2°C, 22.5°C and 23°C (in cores 152SL, NS-14 and HCM2/22 respectively). Our records also show a pronounced centennial-scale cooling that culminates from ~8.2 to 7.6 kyrs BP, coeval to the N. Atlantic cooling event ([7]), causing an interruption in the deposition of S1 in all sites. SST fluctuations are detected between 4.9 and 4.1 kyr BP in core NS-14, with a sharp positive shift to 24.9°C indicating the presence of a warm period in the mid Holocene ([8]). The higher accumulation rates of TOC and all marine biomarkers within the sapropelic layer S1a and less pronounced within S1b in the Aegean Sea compared to the Libyan Sea indicate the importance of productivity – OM reaches the shallower sites more effectively – for the intensity of S1 deposition period. Organic carbon stable isotopes values span a narrow range. The different types of δ^{13}Corg excursions associated with stronger fluvial delivery (terrestrial inputs) in the north Aegean Sea whereas the other two sites received most marine organic matter. The distributions of land-plant biomarkers are indicative of variable terrigenous organic matter supply and the concomitant transport of nutrients to surface waters. Furthermore, the distribution patterns and characteristic ratios of marine biomarkers exhibit differences in the paleoproductivity trends and ventilation changes over the last 20 kyr. Lighter values of δ^{15}N within S1 and Mid Holocene Humid (MHH) phases reflect a significant contribution of N-fixing organisms to the N-cycle related probably to higher demand for nitrogen (denitrification/ P regeneration) due to the established dysoxia in the water column/sediment interface.

References
1 - De Lange, G. J., van Santvoort, P. J. M., Langereis, C., Thomson, J., Corselli, C., Michard, A., Rossignol-Strick, M., Paterne, M., Anastasakis, G., 1999. Palaeo-environmental variations in eastern Mediterranean sediments: a multidisciplinary approach in a prehistoric setting. *Progress in Oceanography* 44, 369–386.
2 - Rohling, E., Mayewski, P., Abu-Zied, R., Casford, J., Hayes, A., 2002. Holocene atmosphere-ocean interactions: Records from Greenland and the Aegean Sea. *Climate Dynamics*, 18, 587-594.
3 - Hilgen, F.J., 1991. Astronomical calibration of Gauss to Matuyama sapropels in the Mediterranean and implication for the Geomagnetic Polarity Time Scale. Earth. *Planet. Sci. Lett.*, 107, 226-244.
4 - Emeis, K.-C., U. Struck, H.-M. Schulz, S. Bernasconi, T. Sakamoto, and F. Martinez-Ruiz, 2000. Temperature and salinity of Mediterranean Sea surface waters over the last 16,000 years: Constraints on the physical environment of S1 sapropel formation based on stable oxygen isotopes and alkenone unsaturation ratios., *Palaeogeography, Palaeoclimatology, Palaeoecology*, 158, 259-280.
5 - Casford, J.S.L., Rohling, E.J., Abu-Zied, R.H., Fontanier, C., Jorissen, F.J., Leng, M.J., Schmiedl, G., Thomson, J., 2003. A dynamic concept for eastern Mediterranean circulation and oxygenation during sapropel formation. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 190, 103-119.
6 - De Lange, G.J., J. Thomson, A. Reitz, C.P. Slomp, M. Speranza Principato, E. Erba, and C. Corselli, Synchronous basin-wide formation and redox-controlled preservation of a Mediterranean sapropel, *Nature Geoscience*, *1* (9), 606-610, 2008.
7 - Rohling, E. J., Pälike, H., 2005. Centennial-scale climate cooling with a sudden cold event around 8200 years ago, *Nature* 434, 975–979.
8 - Triantaphyllou, M.V., P. Ziveri, A. Gogou, G. Marino, V. Lykousis, I. Bouloubassi, K.C. Emeis, K. Kouli, M. Dimiza, A. Rosell-Melι, M. Papanikolaou, G. Katsouras, N. Nunez, 2009. Late Glacial-Holocene climate variability at the south-eastern margin of the Aegean Sea, *Marine Geology*, In Press.

MERCURY ACCUMULATION AND SPECIATION IN RED MULLET (*MULLUS BARBATUS*) AND ANNULAR SEA BREAM (DIPLODUS ANNULARIS) FROM IZMIR BAY (EASTERN AEGEAN)

Tolga Gonul [1]* and Filiz Kucuksezgin [2]
[1] Phd. student - tolga_8135@hotmail.com
[2] Prof. Dr.

Abstract
Total mercury (THg) and methylmercury (MeHg) concentrations were investigated in two different species from the Izmir Bay. The levels of THg and MeHg in fish tissue, ranging from 4.4 to 221.4 µg THg kg^{-1} and 3.8-194.8 µg MeHg kg^{-1} (wet wt.), varied according to sampling point and season. The results indicate that none of the fish analysed was $\geqslant$ 0.500 µg g^{-1} for THg and $\geqslant$ 0.300 µg g^{-1} for MeHg and nor did they exceed the WHO limit [1].
Keywords: Mercury, Fishes, Aegean Sea

Introduction
Izmir Bay, which covers a large range of industries, is one of the great natural bays of the Mediterranean. Few published data are present on total mercury concentrations in organisms from Izmir Bay, but no data are available on mercury speciation in organisms from Izmir Bay. The aim of this study is to comparatively evaluate THg and MeHg concentrations in two fish species collected from different sites of Izmir Bay. Methodology Fish samples were collected at four locations (Foca-Gediz, Uzunada, Gulbahce, Guzelbahce) in 2005 seasonally. THg concentrations were measured in VARIAN AAS by cold vapour technique [2]. The MeHg analysis in the freeze-dried tissue was made by GC-ECD [3].

Results and Discussion
Among the two species, THg and MeHg were examined (Table 1). The percentage of MeHg was high and constant in muscle. The mean percentages of MeHg to THg for all fish samples were 91.0 ± 0.77% (Mean ± SE) with a range of 84–98%, indicating that organic mercury was the predominant form of mercury in the muscle tissue of fish (Table 1). The significant differences between sampling areas for THg and MeHg were not found in muscle tissue of M. Barbatus and D. Annularis while concentrations in muscle tissue of M. Barbatus and D. Annularis differed significantly among seasons for THg and MeHg.

Tab. 1. Range of THg, MeHg, inorganic Hg levels (mg kg^{-1} wet wt.), length (mm) and the ratios of MeHg to THg in biota in sampling areas

Sampling Area	Species	THg	MeHg	InorgHg	MeHg%
Foca-Gediz	*Mullus barbatus*	11.0-103	10.1-96.9	0.88-6.2	92-95
	Diplodus annularis	30.1-132	26.4-112	3.7-19.6	85-88
Gulbahce	*Mullus barbatus*	4.4-82.2	3.8-78.5	0.63-9.8	84-95
	Diplodus annularis	92.6-221	82.4-195	10.2-26.6	88-89
Uzunada	*Mullus barbatus*	20.3-158	17.8-148	2.5-18.1	87-95
	Diplodus annularis	23.1-157	21.9-154	1.2-11.5	90-98
Guzelbahce	*Mullus barbatus*	49.5	45.6	3.9	92
	Diplodus annularis	45.2	41.2	4.0	91

Conclusion
The maximum Hg content was 221.4 µg THg kg^{-1}, corresponding to 194.82 µg MeHg kg^{-1} (wet wt.) in D. Annularis. For a person eating 200-250 g of D. annularis daily, the maximum amount of MeHg ingested is of 39-49 µg daily (273-343 µg weekly), a value of the same order of magnitude as the 210 µg permissible tolerable weekly intake (PTWI) for methylmercury proposed by USEPA [4]. Our results indicated that D. annularis exceeded this limit.

References
1 - WHO, 1990. World Health Organization. Environmental Health Criteria No. 101: Methylmercury. Geneva.
2 - UNEP, 1982. Reference Methods for Marine Pollution Studies, Vol.14.
3 - UNEP/FAO/IAEA/IOC, 1992. Determination of methylmercury in marine organisms. Reference Methods for Marine Pollution Studies, Ref. No.13, Rev.1.
4 - USEPA, 1984. Mercury Health Effects update: Health Issue Assessment: final Report. United States Environmental Protection Agency, Office of Health and Environmental Assessment, EPA 600/884 019F.

UTILISATION DES ECHANTILLONNEURS PASSIFS POUR L'EVALUATION DE LA CONTAMINATION CHIMIQUE DES EAUX MARINES: APPLICATION A LA MEDITERRANEE FRANCAISE

J. Gonzalez [1]*, J. Guyomarch [2], N. Tapie [3], D. Munaron [4], H. Budzinski [3], B. Andral [1] and P. Boissery [5]
[1] IFREMER, La Seyne sur mer, 83507, France - gonzalez@ifremer.fr
[2] CEDRE, 29218 Brest, France
[3] LPTC-ISM Université de Bordeaux I, 33405 Talence, France
[4] IFREMER, 34203 Sète, France
[5] Agence de l'Eau Rhône Méditerranée et Corse, 13001 Marseille, France

Abstract

Les possibilités d'utilisation d'échantillonneurs passifs pour l'évaluation de la contamination chimique des masses d'eau ont été testées dans le cadre du projet PEPS. L'objectif principal était d'évaluer à "grande échelle" et dans différentes conditions de terrain (20 masses d'eau côtières réparties sur l'ensemble de la façade méditerranéenne française) l'opérationnalité de ces systèmes en terme de réduction des coûts, fiabilité et rapidité d'obtention des résultats, mais aussi en terme de facilité de mise en œuvre (par du personnel non spécialisé, mais préalablement formé).

Keywords: Monitoring, Western Mediterranean, Trace Elements, Sampling Methods

L'application de la Directive Cadre Européenne (DCE) [1] implique de mettre en oeuvre des programmes de surveillance de l'état écologique et de l'état chimique de l'ensemble des masses d'eau (de surface et souterraines). Le suivi en routine et à fréquence "élevée" de la contamination chimique est limité du fait que la plupart des contaminants sont présents à l'état de traces dans une matrice complexe (notamment dans le cas de l'eau de mer). Ainsi, l'analyse de la plupart des contaminants en milieu aquatique implique: l'utilisation de techniques d'échantillonnage "ultra-propres"; la mise en oeuvre de méthodes d'extraction/concentration et d'analyse complexes. De plus, l'augmentation importante du nombre de composés chimiques en milieu aquatique, notamment les substances "émergentes", ainsi que les modalités de surveillance des masses d'eaux fixées par la DCE, rendent pertinent le développement d'approches et d'outils "faciles" à mettre en œuvre sur le terrain et pouvant réduire le temps ainsi que les coûts des opérations d'échantillonnage et d'analyse. A ce titre, les échantillonneurs passifs sont des outils intéressants [2]-[7]. Certains ont été conçus pour les éléments métalliques (DGT); d'autres sont utilisés pour les contaminants organiques hydrophobes (SPME, SPMD, SBSE) et pour les molécules polaires (SBSE, POCIS).

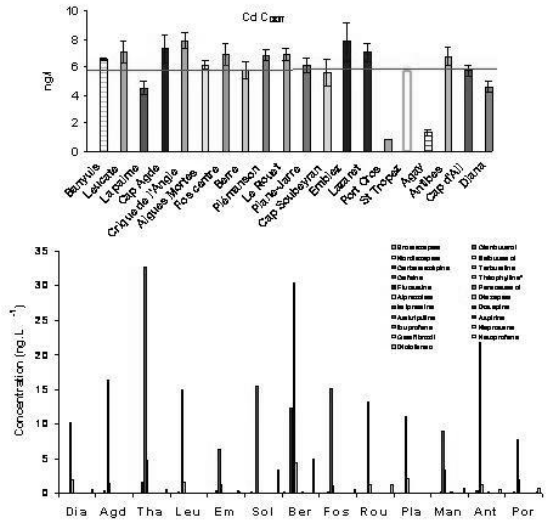


Fig. 1. Exemple de concentrations en Cd (mesurées par DGT) et en certaines substances pharmaceutiques dans les masses d'eau étudiées. Les concentrations en Cd aux différentes stations sont comparées à la concentration moyenne calculée à partir de l'ensemble des concentrations mesurées (ligne rouge).

Ces techniques présentent aussi l'avantage de perturber au minimum la spéciation des contaminants échantillonnés (pas d'opérations de prélèvement d'eau, stockage, filtration) et présentent l'avantage de pouvoir être mises en œuvre rapidement. Cette présentation fera un bilan du test "à grande" échelle de l'opérationnalité de ces techniques (SBSE, POCIS, DGT) réalisé sur la façade méditerranéenne française. Une des originalités de cette étude a été de mettre en évidence l'opérationnalité de ces systèmes et leur facilité de mise en œuvre par du personnel non spécialisé, mais préalablement formé. Les résultats obtenus (Fig. 1) ont contribué à la caractérisation des masses d'eau par rapport à certains contaminants chimiques. Pour certains composés, les données acquises sont parmi les premières disponibles en milieu marin côtier [8].

References

1 - Www.ecologie.gouv.fr/-La-directive-cadre-.html
2 - Vrana, B.; Allan, I. J.; Greenwood, R.; Mills, G. A.; Dominiak, E.; Svensson, K.; Knutsson, J.; Morrison, G., 2005. Passive sampling techniques for monitoring pollutants in water. *TrAC Trends in Analytical Chemistry* , 24 (10): 845-868.
3 - Davison, W.; Zhang, H., In situ speciation measurements of trace components in natural waters using thin film gels. *Nature* 1994, 367: 546-548.
4 - Roy G., Vuillemin R. and Guyomarch J., 2005. On-site determination of polynuclear aromatic hydrocarbons in seawater by Stir Bar Sorptive Extraction and Thermal Desorption GC-MS, *Talanta*, 66, 540-546.
5 - Mazzella N., Dubernet J-F. and Delmas F., 2007. Determination of kinetic and equilibrium regimes in the operation of polar organic chemical integrative samplers: application to the passive sampling of the polar herbicides in aquatic environments, *Journal of Chromatography A.*
6 - Togola A., Budzinski H., 2007. Development of Polar Organic Integrative Samplers for Analysis of Pharmaceuticals in Aquatic Systems. *Analytical Chemistry*, 79: 6734-6741.
7 - Gonzalez J.L., Boutier B. and Griscom S., 2005a. Evaluation of the role of natural organic matter (NOM) on the speciation of metal contaminants: use of passive samplers (DGT). 1st International Workshop on Organic Matter Modeling, WOMM05, Toulon, 16-18 Novembre 2005.
8 - Gonzalez J-L., Tapie N., Munaron D., Budzinski H. (2009). PROJET PEPS Méditerranée (Pré étude: Echantillonnage Passif pour la Surveillance de la contamination chimique). Rapport Convention Cadre Ifremer / AERM&C Utilisation échantillonneurs passifs – Méditerranée - Contrat n° 08/3211080/F. Juin 2009, 90p.

BARIUM IN BLACK SEA SEDIMENTS - REFLECTION OF PRIMARY PRODUCTIVITY OR EARLY DIAGENESIS?

S. Henkel [1]*, K. A. Bogus [2], C. Franke [3], E. Robin [4], A. Bahr [5], G. De Lange [6] and S. Kasten [1]
[1] Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany - susann.henkel@awi.de
[2] Department of Geosciences, University of Bremen, Germany
[3] Centre des Géosciences, Mines ParisTech, Fontainebleau, France
[4] Laboratoire des Sciences du Climat et de l'Environnement, Gif-sur-Yvette, France
[5] Leibniz Institute of Marine Sciences, IFM-GEOMAR, Kiel, Germany
[6] Institute for Earth Sciences, Utrecht University, Netherlands

Abstract

Barite is not restricted to reconstruction of paleoproductivity. If its sedimentary distribution underwent diagenesis, it can reflect changes in sedimentation rate, CH_4 and SO_4^{2-} fluxes. We present data from two cores retrieved in the Black Sea (BS). In contrast to Mediterranean sapropels, where Ba is used as tracer for organic matter accumulation, the primary Ba signal in the BS was lost in shallow sediment depths (>1.5 m). While Ba is inappropriate as a paloeproductivity proxy in the BS, it might serve as a tracer of the sulphate-methane transition (SMT). Migration of the SMT induced by the flooding of the BS was simulated using a numerical model. The results indicate that diagenetic $BaSO_4$ redistribution did not affect the top ~0.8 m of the cores. Steady state could have prevailed since 3.8 ka after the first intrusion of seawater.

Keywords: Black Sea, Sediments, Geochemistry

The Black Sea has experienced severe changes after the last deglaciation concerning its hydrological and geochemical conditions. Due to the flooding by Mediterranean waters, conditions developed from a lacustrine setting with an oxic water column to the largest modern marine anoxic basin in the world. These changes affected the geochemical zonation within the sediment column, pushing the SMT downward and enhancing organic matter (OM) preservation. In ocean basins, barite Ba concentrations in the sediment can be used to reconstruct paleoproductivity [1]. Particularly in the Mediterranean Sea, Ba is a helpful indicator for the original extent of sapropels, which have been affected by post-depositional "burn-down" [2]. However, in zones of sulphate depletion, $BaSO_4$ is subject to dissolution. This diagenetic overprint is decisive for Ba cycling in Black Sea sediments, where the SMT is located at shallow depths of 2-4 m. The authigenic $BaSO_4$ fronts that form at (or slightly above) the SMT potentially record the movement of the SMT [3]. This study is the first to present solid phase Ba data of Black Sea sediments in combination with pore water data. The main questions are: 1) Do distinct Ba/Al variations appear in the sedimentary record? If yes – 2) Does the Ba signal reflect productivity or diagenetic redistribution of $BaSO_4$? And 3) Can relict fronts be used to trace the movement ot the SMT and thus changes in sedimentation rate or the upward methane flux? Two gravity cores 755 (501 m water depth) and 214 (1686 m water depth) were retrieved west of the Crimean Peninsula during RV POSEIDON cruise 317/2 (2004) and RV METEOR cruise M72/1 (2007). In addition to wet geochemical analyses, scanning electron microscopy (SEM) and energy dispersive spectrometry (EDS) were carried out on bulk sediments to identify the main Ba phases. Pore water profiles indicated barite dissolution below the SMT and precipitation of authigenic $BaSO_4$ fronts at the base of the sulphate zone (Fig.1). By SEM-EDS, barite crystals with sizes <3 µm were found in five samples above the current depth of the SMT. Most of those crystals were irregularly shaped and only a few grains showed morphologies characteristic of biogenic barites. The movement of the SMT since the Holocene flooding of the Black Sea was simulated using a numerical transport and reaction model. The results demonstrate that due to time constraints arising from sedimentation rates and the velocity of diffusion, the upper ~80 cm of the sediment column are not affected by diagenetic barite redistribution. A coupling of OM and Ba in these intervals can be recognised, although the correlation is still ambiguous. The sediments showed an opposite pattern to that in Mediterranean sapropels: OM is well preserved while $BaSO_4$ was efficiently remobilized. Ba is therefore not applicable for studying paleoproductivities in the Black Sea. These findings also suggest implications for the use of the Ba-proxy in analogue ancient settings.

Acknowledgements: We thank the participants of the cruises P317/2 and M72/1. This study was funded by the DFG International Graduate College 'Proxies in Earth History' (EUROPROX) and the Helmholtz Association.

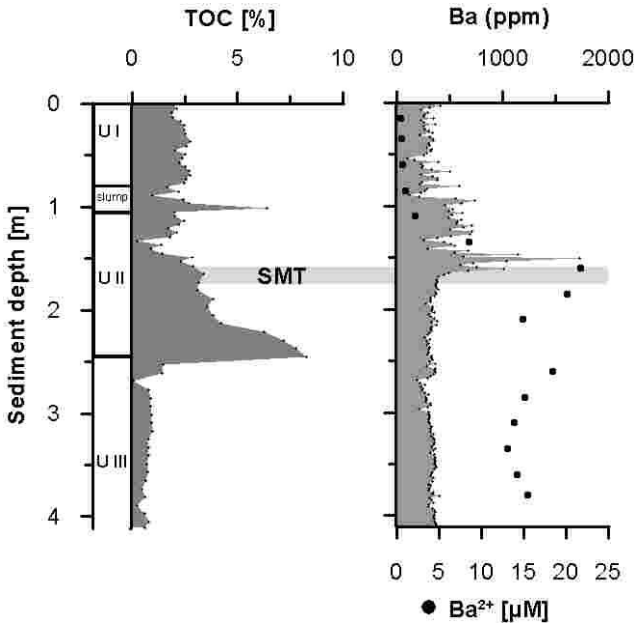


Fig. 1. Total organic carbon (TOC), solid phase and dissolved Ba of core 214. The stratigraphy (Units I-III) was established by Blumenberg et al. [4]. Dissolution of $BaSO_4$ and thus decoupling of Ba from the initial TOC input is observed below the SMT.

References

1 - Dymond J., Suess E. and Lyle M. (1992) Barium in deep-sea sediments: A geochemical proxy for paleoproductivity, *Paleoceanography*, 7: 163-181.

2 - Van Santvoort P.J.M., De Lange G.J., Thomson J., Cussen H., Wilson T.R.S., Krom M.D. and Strohle K. (1996) Active post-depositional oxidation of the most recent sapropel (S1) in sediments of the eastern Mediterranean Sea. *Geochim. Cosmochim. Acta*, 60: 4007-4024.

3 - Dickens G.R. (2001) Sulfate profiles and barium fronts in sediment on the Blake Ridge: Present and past methane fluxes through a large gas hydrate reservoir. *Geochim. Cosmochim. Acta*, 65: 529-543.

4 - Blumenberg M., Seifert R., Kasten S., Bahlmann E. and Michaelis W. (2009) Euphotic zone bacterioplankton sources major sedimentary bacteriohopanepolyols in the Holocene Black Sea. *Geochim. Cosmochim. Acta*, 73: 750-766.

SUBMARINE BAUXITIC TAILINGS DISPOSAL: A CASE STUDY IN CORINTH GULF, CENTRAL GREECE

Margarita Iatrou [1]*, George Papatheodorou [1], Maria Geraga [1] and George Ferentinos [1]
[1] Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, - iatroum@upatras.gr

Abstract
A Submarine Tailings Disposal (STD) system operates on the northern flank of the Corinth Gulf , discharging bauxitic tailings on the shelf of the Gulf. A deposit of three high relief mounds has formed at a water depth of about 100 m. The surface of the mounds suffers from instabilities and tailings are transported as slumps down-slope. The tailings are dispersed on the shelf floor and are directed through the channels and canyons of the slope, to the basin floor where they form thin intercalating layers. Tailings have increased significantly the level of heavy metals in the study area.
Keywords: Metals, Pollution, Sediment Transport, Eastern Mediterranean

Introduction
On the northern margin of the Corinth Gulf, in Antikyra Bay, is located a bauxitic processing plant, Aluminium of Greece, which has contributed significant amounts of bauxitic tailings to the marine environment through a submarine tailings disposal system (STD). Throughout 20 years period, four (1982-83, 1987, 1994, and 2007) multidisciplinary environmental surveys were carried out in Antikyra Bay and in the Corinth Gulf basin, in order to monitor the STD system [1,2,3] and study the dispersion and transport mechanism of bauxitic tailings as well as the distribution of heavy metals concentration. The STD system discharges red mud slurry as the by-product of the aluminum production. Though the STD system the tailings are piped out at water depth of 100 -120m.

Results-Discussion
On the shelf the tailings have formed three high-relief overlapping mounds at the mouths of the pipelines, modifying significantly the bathymetry of the seafloor (Fig.1).

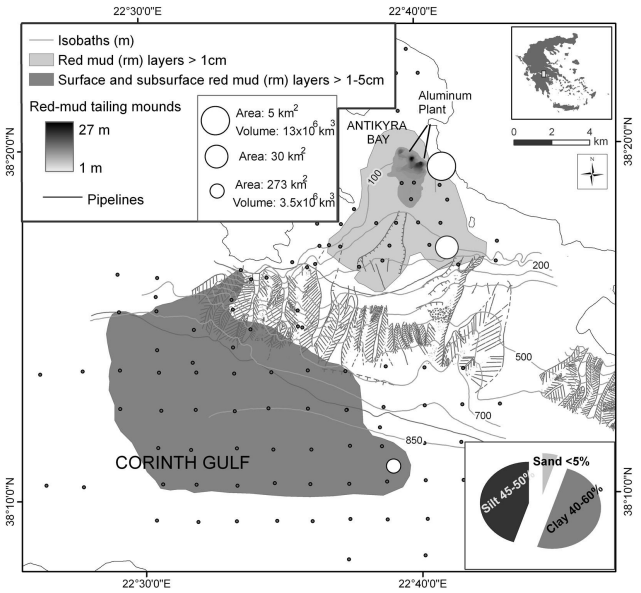


Fig. 1. Morphologic map of the central Gulf of Corinth showing the spatial distribution of bauxitic tailings. Inset shows the bulk granulometric composition of the tailings.

The mounds have wedged down-slope margins. The high rates of accumulation at the mouth of the pipelines, in association with the high seismicity of the area facilitate the instability of the mounds and the initiation of gravitative mass movements (such as slumps) as it is indicated by the surficial patterns of arcuated scarps. The red-mud tailings disperse from the mounds on the shelf floor in a down-slope direction and form an elongated main surface deposit. The distal tailings deposit is distributed down-slope from the main deposit as far as the shelf-break and thins out to 1 cm. The bauxitic tailings are transported as gravity–driven mass flows through the numerous channels incising the slope, to the basin where they are being deposited, at a depth of 800 - 850 m on a smooth and flat seafloor. On the base of slope and the basin floor, the red bauxitic tailings have formed successive layers, which intercalate with natural sediments. The "red-mud" tailings and the intercalated natural sediment, consist of medium to fine-grained sediments. The tailing deposits are highly enriched in Fe_2O_3, TiO_2, Cr_2O_3, Ni, Co, Pb and Cu compared to the surrounding natural sediments, while the natural sediments are characterized by higher concentrations of Mn, Zn and $CaCO_3$. The concentrations of Fe_2O_3, TiO_2, Cr_2O_3, Ni, Co, Pb and Cu are highest the mouths of the outfalls in Antikyra Bay (Table 1) and they decrease towards the basin. Therefore the tailings during their transport as gravitational mass flows from the outfalls as far as their final deposition site on the basin are subjected to mixing with natural sediments.

Tab. 1. Metal concentrations of bauxitic tailings and natural sediments in the study area

	Antikyra Bay		Corinth Gulf Basin	
	Red Mud	Natural Sediments	Red Mud	Natural Sediments
	Mean	**Mean**	**Mean**	**Mean**
Fe (%)	35.8	8.0	35	5.3
Cr (ppm)	3441	172	1120	62
Ti (%)	5.4	0.5	2.3	0.3
Ni (ppm)	1624	213	1147	66
Co (ppm)	103	37	92	21
Pb (ppm)	162	64	131	18
Cu (ppm)	133	83	133	48
Hg (ppm)	5	-	2.8	-
Al (%)	13.1	4.7	12.1	7.0
Ag (ppm)	9.6	0.5	7.3	-
V (ppm)	673	160	571	157
Cd (ppm)	10	0.2	7.9	-
Si (%)	5.6	35.3	6.5	26.9
Mg (%)	-	6.1	-	4.9
Mn (ppm)	1325	4883	2914	4714
Zn (ppm)	108	108	135	292

References
1 - Papatheodorou G., 1991. Sedimentation in the Gulf of Corinth. PhD thesis, University of Patras, p230.
2 - Papatheodorou G., Stefatos A., Christodoulou D. and Ferentinos G., 2003. Small scale present day turbidity currents in a tectonically active submarine graben, the Gulf of Corinth (Greece): Their significance in dispersing mine tailings and their relevance to basin filling. *In*: J. Locat & J. Mienert (eds), Submarine Mass movements and their consequences. Netherlands, Kluwer Academic Publishers, pp 459-468.
3 - Iatrou M., Ferentinos G., Papatheodorou G., Piper D.J.W. and Tripsanas E. 2007. Anthropogenic turbidity current deposits in a seismically active graben, the Gulf of Corinth Greece: a useful tool for studying turbidity current transport prcesses. *In*: V. Lykousis, D. Sakellariou and J. Locat (eds.), Submarine Mass movements and their consequences. Springer, pp 149-157.

TRACE METAL POLLUTION IN SEDIMENTS OF THE CATALAN COAST (NORTHWESTERN MEDITERRANEAN)

Marc Belzunces Ibañez [1]*, Albert Palanques Monteys [1] and Mariona De Torres [2]
[1] Institut de Ciències del Mar (CSIC) - marcbel@icm.cat
[2] Agència Catalana de l'Aigua

Abstract
A survey along the Catalan coast was carried out in 2007 to assess trace metals in sediments with a homogenous sampling and analytical strategy. The nine prodeltaic systems and adjacent areas of this coast were studied as sinks of polluted sediments in the continental shelf. Results show that North part of the coast presents background levels or low isolated alterations. South part of the coast, including the Ebro, Besòs and Llobregat prodeltas, presents high enrichment factors for several elements. Cadmium, and specially Mercury, presents very high enrichment factors around the metropolitan areas of Barcelona and Tarragona.
Keywords: Trace Elements, Pollution, Ebro Delta, Sediments, Mercury

Introduction
The irregular regime of the small rivers discharging in the Catalan coast and also uncontrolled pollutant dumpings result in sporadic pollution. This produces anomalous trace metal contents in bottom sediments of active prodeltaic accumulation areas that are indicative of sedimentary systems affected by pollution.
Studies about trace metals in sediments of the Catalan coast have been carried out mainly in specifics areas, in different years and following different sampling strategies and analytical methods (Palanques et al. 1994). The present study provides homogeneity in sampling and analytical procedures in the study of trace metals in the sediments of the Catalan coast.

Material and methods
A total of 118 samples of surface sediment (first centimeter) were taken in the 9 prodeltas and adjacent areas of the Catalan coast (Figure 1). Transects of five stations perpendicular to the bathymetric isolines were established, taking surface sediment samples at 10, 20, 30, 40 and 50 meters depth.

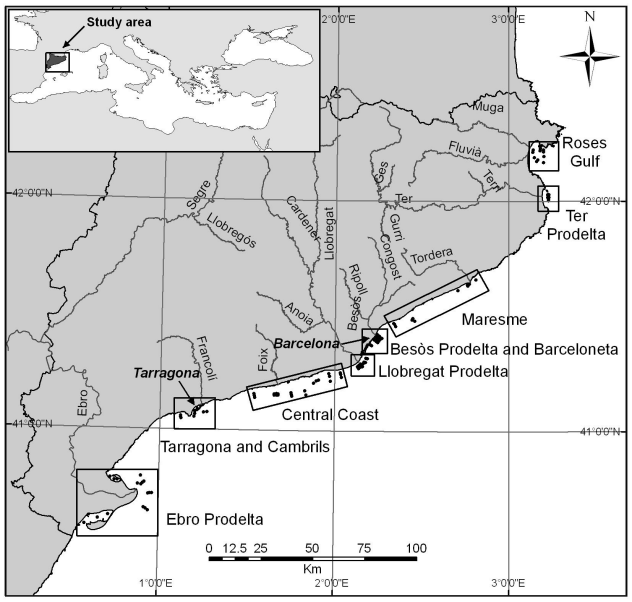


Fig. 1. Study area with samples in black dots grouped in zones.

Grain size of all samples was determined by a sedigraph (fine fraction) and a settling tube (coarse fraction) according to Giró et al. (1985). For geochemical analysis, a total digestion technique was carried out, according to Querol et al. (1996). Pb, Cr, Cu, Cd, Ni and Zn content was determined by ICP-MS, Fe and Al content by ICP-OES and Hg content by a specific mercury analyzer.
GIS analysis and representation of data were performed with ESRI ArcGIS 9.3.

Results and discussion
To obtain the enrichment factors (EF), samples were normalized by Al content. Results for every metal were compared to unpolluted samples of previous studies, including pre-industrial samples from sediment cores. Table 1 summarizes EF ranges for every area (Figure 1).
Samples from the northern of Barcelona metropolitan coastal area (Northern Maresme, Ter prodelta and Roses Gulf) presented natural or near natural EF, with some isolated pollution signals.
General high EF were present in the Barcelona metropolitan coastal area (Southern Maresme, Besòs and Llobregat prodeltas and Northern Central Coast), an area heavily populated and industrialized (4.9 million inhab.). In general, maximum EF were founded in Besòs prodelta, up to 38 for Hg (up to 2.5 µg/g), up to 10 for Cd (1.4 µg/g), up to 6.4 for Cu (up to 137 µg/g), up to 7 for Pb (173 µg/g), up to 4.9 for Cr (251 µg/g) and up to 5.7 for Zn (450 µg/g). In this area, pollution is associated to sewers and the Besòs and Llobregat rivers. Tarragona area, which hosts petrochemical industry facilities, showed the highest EF for Hg in the Catalan Coast (EF 126, 4.6 µg/g). Hg pollution is associated to the several sewers in the area. Rest of metals showed natural levels (Ni and Pb) or EF below 3 (Cd, Cr and Zn).
The Ebro prodelta, the larger system, showed significant EF only near the river mouth (Hg up to 8) and in its Bays (Cd up to 3), probably due to retention of polluted sediment in the numerous dams throughout its basin and also to the higher dilution of polluted particles in a river with high water discharge.

Tab. 1. Enrichment factor (EF) ranges for every area (Natural EF=1).

Area	Hg	Cd	Ni	Cu	Pb	Cr	Zn
Roses	0.6-1.6	0.8-1.6	0.0-1.0	0.6-1.8	0.6-1.3	0.8-1.7	0.8-1.6
Ter	0.5-25.7	1.1-2.1	0.8-1.0	0.8-1.2	0.7-1.7	0.9-1.1	1.2-1.5
Maresme	0.3-8.39	0.2-1.1	0.0-0.5	0.1-1.2	1.3-2.9	0.0-1.0	0.2-1.7
Besòs	4.8-37.6	2.1-10.0	0.6-1.1	2.0-6.4	1.2-7.1	1.5-4.9	2.1-5.7
Llobregat	2.0-8.7	1.8-3.8	0.9-1.2	1.6-2.8	0.6-1.5	1.4-2.0	1.5-2.4
Central Coast	0.4-14.3	0.2-3.6	0.5-1.2	0.4-3.4	0.9-2.0	0.4-2.8	0.4-2.8
Tarragona	4.3-126.3	1.0-2.5	0.5-1.2	0.7-2.3	0.8-1.1	0.6-1.4	0.8-2.0
Ebro	0.8-8.1	1.1-2.9	0.9-1.2	0.5-1.4	0.4-0.9	0.9-1.4	0.6-1.4

References
1 - Giró, S. and Maldonado, A., 1985. Análisis granulométrico por métodos automáticos: tubo de sedimentación y sedigraph. *Acta Geològica Hispànica* t. 20 nº 1, p. 95-102.
2 - Palanques, A. and Díaz, J.I., 1994. Anthropogenic heavy metal pollution in the sediment of the Barcelona continental shelf (Northwestern Mediterranean). *Marine Environmental Research* 38, p. 17-31.
3 - Querol X., Alastuey A Lopez-Soler A, Mantilla E, Plana F., 1996. Mineralogy of atmospheric particulates around a large coal-fired power station. *Atmos Environ* 30(21):3557-3572.

FUTURE OCEAN ACIDIFICATION IMPACTS ON MEDITERRANEAN SEAFOODS: FIRST INVESTIGATION OF THE ECONOMIC COSTS

Ross Jeffree [1]*, Nathalie Hilmi [2], Denis Allemand [2] and James Orr [3]
[1] IAEA Marine Environment Laboratories - R.Jeffree@iaea.org
[2] Centre Scientifique de Monaco
[3] LSCE/IPSL, CEA-CNRS-UVSQ

Abstract

There is increasing concern with regard to future impacts of ocean acidification on marine biological resources, fisheries and aquaculture and the potential economic and social consequences. Here we give a summary report on the status of following sets of data required to evaluate the likely scales of future economic losses to Mediterranean fisheries and aquaculture; a) direct and indirect effects of reduced pH on Mediterranean species of socio-economic significance, b) effects of different global atmospheric carbon emission rates on future acidity of Mediterranean seawater, and c) the economic values of shellfish from both wild fisheries and aquaculture industries. The areas of uncertainty that warrant further investigation are also identified.
Keywords: Ph, Aquaculture, Global Change, Fisheries

Ocean acidification (OA) refers to changes in ocean chemistry brought about by increases in atmospheric CO_2 from combustion of fossil fuels, deforestation and cement production. Ocean acidification leads to an increase in hydrogen ion concentration [H^+], which we refer to as acidity, and thus a decrease in pH (defined as $-\log[H^+]$) and carbonate ion concentration. The Mediterranean Sea is a semi-enclosed basin with different properties than typical seawater, including generally higher surface temperatures and salinities. However, the 21st-century reductions in Mediterranean Sea surface-water pH and carbonate ion concentration are expected to be similar to those in tropical waters of the ocean. Yet unlike the tropics, in the Mediterranean Sea there are large differences between winter and summer saturation levels (carbonate ion concentration). Combined effects from other peculiarities, including different marine ecosystems and intense anthropogenic pressures, necessitate distinct initiatives to study Mediterranean Sea acidification. For the Mediterranean Sea there is little scientific information on the likely effects of ocean acidification on marine food webs, fisheries and aquaculture species. However many of the taxonomic groups of organisms present in the Mediterranean are also found elsewhere where many of the ocean acidification studies are currently focussed [1].Our approach has been to first assess the current state of knowledge of the impacts of ocean acidification on seafoods and specifically for the Mediterranean, including potential indirect effects through disruption of food webs, and in combination with the effects of co-contaminants and increasing temperatures. Then we use this assessment to interpret biological and ecological impacts in the context of projected future acidification of the Mediterranean. We then present some macro-economic assessment of the value of Mediterranean seafoods at the regional and national scale to determine what is potentially at threat economically from ocean acidification in the future. By undertaking this preliminary cross-disciplinary study of the economic significance of ocean acidification for Mediterranean seafoods we have also better evaluated the inadequacies of the economic and scientific data for the Mediterranean that is currently available for such a purpose. We have also proposed what is needed to better assess the economic costs and risks, with a prioritisation of the requirements for new information to reduce the uncertainties in such an analysis. Ocean acidification is a recently identified phenomenon and the scientific assessment of its impacts on seafoods and underpinning biodiversity is still in its infancy, particularly for the Mediterranean. Its tentative nature has constrained the precision of our socio-economic analyses. However, the scale of potential losses has been better clarified and detailed for Mediterranean countries, for the groups of seafoods that are currently identified as more at risk from OA. Moreover, the following questions have been better shaped through our collaborative analyses to indicate where the needs for further research and consideration lie, viz: i) the higher alkalinity of Mediterranean water mitigates the rate at which it will acidify, however the biological responses of organisms that have also evolved under these conditions need to be assessed experimentally, to discern the degree of their vulnerability, ii) such experimental assessments need to be undertaken within the ranges of pH values that are projected to occur, with longer-term exposures, and for those species that have been identified as of particular economic value for individual countries, iii) particular countries are also identified as being pre-disposed to greater socio-economic impact of OA due to both the value of calcifiers in their seafood production coupled with the narrow species base of their seafood industries, iv) assessment of the potential scale of socio-economic impacts of OA and the equity of their distributions among the Mediterranean countries, that represent a very broad range in their states of economic development. By its diversity among member states in their level of economic development and the resilience of their economies, the Mediterranean offers the unique opportunity to investigate the different scales of socio-economic impacts among countries of OA [2].

References

1 - Fowler S. W. (2009). Ocean Acidification Issues in the Mediterranean and Black Seas: Present Status and Future Perspectives. *Proc. CIESM Workshop* No. 36

2 - Hilmi N., Allemand D., Jeffree R., Orr J. (2009). Future economic impacts of ocean acidification on Med seafoods: first assessment summary. Proc. 9th Int. Conf. on the Medit. Coastal Envir., 13-17 Nov., Sochi, Russia, pp. 12.

PHYLOGENETIC CONSISTENCIES IN RADIONUCLIDE AND METAL ACCUMULATION BY TELEOST AND CHONDRICHTHYAN FISHES OF THE MEDITERRANEAN

Ross Jeffree [1]*, Francois Oberhaensli [1] and Jean Louis Teyssie [1]
[1] IAEA Marine Environment Laboratories - R.Jeffree@iaea.org

Abstract

There is a need to explain why different organisms contrast greatly in their capacities to accumulate trace element contaminants. Such understanding will enhance predictive ecological risk assessment for these contaminants and permit better evaluation of the 'reference organism' approach to radiation protection [1,2,3]. More fundamental biological explanations of these differences in bioaccumulation between different organisms are yet to be achieved. Experimental investigations have shown consistencies within teleost and chondrichthyan fish in their patterns of bioaccumulation of multiple trace elements. Such patterns are indicating phylogenetically-based predispositions for elevated boaccumulation and internal exposures among these contaminants.

Keywords: Teleostei, Bio-Accumulation, Elasmobranchii, Metals, Radionuclides

To test the hypothesis of taxon-based bioaccumulation patterns we had previously conducted a 14 day uptake/ 29 day loss experiment of uptake from seawater that compared the whole-body uptake and loss kinetics of seven radiotracers in a teleost (turbot- *Psetta maxima*) and chondrichthyan (lesser dogfish- *Scyliorhinus canicula*) . This experiment showed appreciable differences ($P \leqslant 0.01$) between the two species in their rates of accumulation for multiple elements (eg. Am-241, Zn-65 and Cs-137) [4], which were great enough to warrant further assesment of the hypothesis, as described below. A set of nine radiotracers in seawater were used for an experimental exposure that compared their whole body: water concentration factors at 14 days in each of three teleosts and three chondrichthyans. Radiotracers included the anthropogenic radionuclides ^{54}Mn, ^{60}Co, ^{65}Zn, ^{134}Cs and ^{241}Am that are typically released into coastal waters from nuclear power stations, and that could be expected to increase in the future due to enhanced nuclear power programs that are planned. Radiotracers of Cd, Ag and Se were also included as they are contaminants that are commonly elevated in coastal waters due to effluents from land-based sources. Teleost fish species were turbot *Psetta maxima*, Order Pleuronectiformes, Family Psettodidae, sea bream *Sparus aurata*, Order Perciformes, Family Sparidae and sea bass *Dicentrarchus labrax*, Order Perciformes, Family Serranidae. The chondrichthyans were dogfish *S. canicula*, Order Carcharhiniformes, Family Scyliorhinidae, undulate ray *Raja undulata*, Order Rajiformes, Family Rajidae and spotted torpedo *Torpedo marmorata* Order Torpediniformes, Family Torpedinidae. Discriminant function analysis was used to determine an equation to best separate between dogfish and turbot on the basis of their CFs among 7-9 radiotracers. This function could then be used to objectively classify individuals of the other chondrichthyan and teleost species used in this experiment, as being closer to the *a priori* chondrichthyan or teleost 'bioaccumulation model'. Hierarchical classificatory, multi-dimensional scaling (MDS) and similarity (ANOSIM & SIMPER) analyses were also used to further assess the hypothesis of different bioaccumulation characteristics for species of teleosts and chondrichthyans. These analyses also identified those trace elements that were most different between them in their bioaccumulatory capacities. Discriminant function analysis on whole body: water concentration factors (CFs) for 7-9 radiotracers separated dogfish and turbot in the two independent experiments. Associated classification functions grouped the teleosts, seabream and most seabass with turbot and the chondrichthyans, undulate ray and spotted torpedo with dogfish, thus supporting our initial hypothesis of taxon-based boacumulation patterns. Hierarchical classificatory, multi-dimensional scaling and similarity analyses also separated all three teleosts from all chondrichthyans that were more diverse amongst themselves compared to teleosts. Dogfish were the most distant from teleosts, followed by the undulate ray and then torpedo. Among the several multivariate statistical techniques that were used to compare between taxa there were trace elements that were repeatedly more prominent in determining the separations between teleosts and chondrichthyans, based on their CFs, viz. Cs-134 was consistently elevated in teleosts and Zn-65 was elevated in chondrichthyans. Chondrichthyans were also higher in Cr-51, Co-60, Ag-110m and Am-241, whereas teleosts were higher in Mn-54. Our results suggest that chondrichthyans may be more susceptible to contamination from exposures in seawater for a greater range of trace elements, compared to teleosts.

References

1 - Brechignac F 2006. Protecting the environment against ionising radiation: the path proposed by "ICRP", its origins and analysis. In G.Arapis et al. (eds), Ecotoxicology, Ecological Risk Assessment and Multiple Stressors, 41-55.

2 - Luoma S N & Rainbow P S 2005. Why is metal bioaccumulation so variable? Biodynamics as a unifying concept. *Environmental Science and Technology* 39: 1921-1931.

3 - IAEA. 2004. Sediment Distribution Coefficients and Concentration Factors for Biota in the Marine Environment. Technical Report Series No. 422.

4 - Jeffree R.A, Warnau M. ,Teyssie J-L. , Markich S.J.2006.Comparison of the bioaccumulation from seawater and depuration of heavy metals and radionuclides in the spotted dogfish *Scyliorhinus canicula* (Chondrichthys) and the turbot *Psetta maxima* (Actinopterygii: Teleostei). The Science of the Total Environment, 368, 839-852.

IMPACT OF AQUACULTURE ON NUTRIENT DISTRIBUTION IN AEGEAN SEA

Janset Kankus [1]*, Nihayet Bizsel [1], Sezgi Adalioglu [1] and Sebnem Kuscu [1]
[1] Dokuz Eylül University, Institute of Marine Sciences and Technology - jansetkankus@gmail.com

Abstract
To observe the potential impacts of the aquaculture site, the nutrient distirbution (ammonium, nitrite, nitrate, phosphate and silicate), and their ratios have been monitored as the indicators of water quality in a well-known aquaculture area in the middle of Aegean Sea during winter and summer period. In addition to the nutrients, the total suspended solids (TSS) and dissolved oxygen (DO) were also determined. The spatial variability in the nutrient distribution shows that the effect of fish farm and freshwater tributaries input flow throughout the agricultural areas on the water quality parameters have no differences. The nutrient ratios (N/P/Si=1:5:1 in winter; N/P/Si=1,5:2:1 in summer) indicate that nitrate and silicate are limiting.
Keywords: Aquaculture, Nutrients, Aegean Sea

Introduction
During last two decades, the intensification of marine aquaculture in the Mediterraneancoasts has been reacted by the other users. Among these users, the tourism entrepreneurs have been leading a competition based on the conflict of interest for coastal zones. Their main argument is the adverse impacts of fish farms on marine ecosystems. On one hand, the over sprawled fish farms in coastal zones, which Turkey is well behind in comparison with Greece with her ability to supply 60% of EC's demand for Mediterranean fish [1] and on the other hand, the sharp increase in world's demand for seafoods from 120 million tonnes towards to 160 million tonnes, display the conradictory nature of the issue. An effective monitoring programme for the fish farming activities is therefore important and essential. As the consequence of such a programme, the sustainability of marine aquaculture can be acquired by considering tourism, fisheries and aquaculture, and environmental protection via the perspective of integrated coastal zone management. The number of fish farms is relatively quite limited in Turkey, however, their adverse environmental impacts are highly speculated in spite of the highly restricted number of scientific monitoring researches on this issue.

Materials and Methods
Dissolved oxygen (DO) were measured by Winkler method. The filtered water samples were kept frozen for analysis in the laboratory. SiO and NO were analyzed using the Grasshoff, Ehrhartd and Kremling (1983) method, and (NO + NO), NH PO following Strickland and Parsons (1972) [2,3]

Results and Discussion
In the present study, the annual nutrient variations were given in the min and max ranges in Table1.
As expected, nutrients were higher in winter than ones in summer period. NO :PO ratios are almost stable during the two seasons. However, TIN:PO and Si:PO show changes. While TIN:PO is increasing, Si:PO is decreasing in summer period.

Tab. 1. Annual variation of water quality parameters with nutrients

Parameters	STATIONS					
	K1	K2	Coastal station		Ref.	
	Surface	Surface	Surface	Bottom	Surface	Bottom
NO2 µM	1,268-2,79	0,050-0,460	0,001-0,12	<0,001-0,26	0,001-0.005	<0,001-0,051
NO3 µM	2,149-8,68	0,119-21,995	0,043-1,85	0,051-2,032	0,095-0,297	0,049-0,341
NH4 µM	2,630-290	0,101-10,030	0,060-17,53	<0,060-7,07	0,06-1,268	0,225-0,853
Si µM	3,010-29,58	4,525-55,540	0,037-3,22	0,152-2,8	0,732-1,988	0,848-1,835
PO4 µM	1,405-5,85	0,111-0,129	0,005-0,08	0,010-0,1	0,018-0,124	0,045-0,082
DO ml/l	5,91-7,02	5,96-9,86	4,43-7,52	4,45-7,17	4,82-5,16	4,72-5,25
TSS mg/l	14,23-16,20	7,14-45,41	0,10-2,90	0,60-11,30	0,00-0,39	0,00-0,60

Tab. 2. Nutrient ratios during winter and summer periods

Ratio	Winter	Summer
NO_3:PO_4	1,08	1,49
TIN:PO_4	1,47	10,04
Si:PO_4	4,74	2,02*

*non-significant According to eutrophication scale given by Kardydis,1999 [4],the levels of nutrients near the fish and freshwater outfall reached the eutrophic level for phosphate and ammonium and ammonium, respectively.

References
1 - Http://www.dtcsee.um.dk/en/menu/ServicesOffered/Sectoroverview/
2 - Strickland J. D. H. , Parsons TR., 1972. A practical handbook of seawater analysis. Fishery Research Board, Canada
3 - Grasshoff K. , Ehrhardt M., Kremling K. , 1983. Methods of seawater analysis. Verlag Chemie, New York
4 - Karydis, M. 1999. Evaluation report on the eutrophication level in coastal greek areas. Univ. of Aegean, Mytilini, February 1999 (in greek).

VARIATION DES TENEURS EN ELEMENTS MINERAUX DANS LE MUSCLE DE QUATRE ESPECES DE POISSONS

Ilhem Ketata Khitouni [1]*, Abderrahmen Bouain [1], Abdelwaheb Abdelmouleh [2] and Nourhen Boudhrioua Mihoubi [3]
[1] Laboratoire de Biologie Animale, Faculté des Sciences de Sfax B. P. 802 –Sfax - ilhem_ketata@yahoo.fr
[2] Laboratoire de Biotechnologie, Institut National des Sciences et Technologies de la Mer –Sfax, Tunisie
[3] Groupe des Procédés Agroalimentaires, Ecole Nationale des Ingénieurs de Sfax, BP 1173, 3038, Sfax,

Abstract
Les teneurs de neuf éléments minéraux (K, Mg, Na, Ca, Fe, Cd, Pb, Zn et Cu) dans le muscle dequatre espèces de poissons de la pêche côtière du golfe de Gabès (le sparaillon *Diplodus annularis,* le gobie *Zosterisessor ophiocephalus*, le mulet *Liza aurata* et le saurel *caranx rhonchus)* ont été déterminés dans le mois d'avril 2008. La variation des teneurs en minéraux en fonction du sexe de poissons et des espèces a été examinée. Une grande variabilité entre les deux sexes est observée pour les éléments majeurs (K, Mg, Na, Ca). Pour les éléments mineurs (Cu, Cd et Pb) peu de variations.
Keywords: Mineralogy, Fishes, Chemical Analysis

Introduction
L'analyse des teneurs en éléments minéraux permet d'évaluer le degré de contamination dans les rejets industriels dans la mer. Le golfe de Gabès assure une production halieutique importante en Tunisie. Cependant cette zone est de plus en plus industrialisée. L'objectif de cette étude est d'analiser les teneurs en éléments minéraux majeurs et mineurs dans quatre espèces de poisons de la pêche côtière du golfe de Gabès (le sparaillon *Diplodus annularis,* le gobie *Zosterisessor ophiocephalus,* le mulet *Liza aurata* et le saurel *caranx rhonchus).*

Matériel et methods
Un échantillon de 4g d'extrait sec de la chair totale est calciné dans un four à moufle à 550°C jusqu'à minéralisation complète de l'échantillon. 15 ml de HNO_3 dilués (1+ 4) avec de l'eau désionisée est ajouté à l'échantillon minéralisé [1]. Le filtrat est analysé en éléments minéraux : Ca, Mg, Na, Fe, Cd, Pb, Cu et Zn par la spectrophotomètre d'absorption atomique (Z_{6100} polarized Zieman, Atomic Absorption Spectrophotometer Hitachi, Japon). Les résultats représentent le moyen (moyen ; n = 3).

Tab. 1. Teneurs en éléments mineurs et majeurs obtenus dans la chair des quatre espèces de poisons examinées.

		Eléments majeurs				Eléments mineurs				
		K	Mg	Na	Ca	Fe	Cd	Pb	Zn	Cu
Sparaillon	Ma n=8	35.04	7.06	19.47	12.62	0.09	0.002	0.011	0.18	0.007
	Fe n=8	46.84	7.77	24	14.6	0.11	0.002	0.011	0.016	0.009
Gobie	Ma n=11	51.64	9.97	20.49	9.24	0.06	0.002	0.012	0.097	0.006
	Fe n=12	117.69	14.34	48.62	19.93	0.14	0.004	0.022	0.024	0.016
Mulet	Ma n=3	36.25	5.24	10.94	5.42	0.09	0.001	0.007	0.076	0.003
	Fe n=3	14.49	1.8	3.89	2.3	0.03	< 0.001	0.003	0.004	0.002
saurel	Ma n=4	14.55	2.39	4.99	3.86	0.04	< 0.001	0.004	0.05	0.003
	Fe n=7	16.51	2.6	6.17	4.98	0.05	< 0.001	0.005	0.009	0.004

Résultats et discussion
Le tableau 1 récapitule les teneurs en éléments mineurs et majeurs obtenus dans la chair des quatre espèces de poisons examinées. Pour toutes les espèces étudiées les femelles sont plus riches en éléments minéraux majeurs. Pour le calcium les femelles contiennent entre 2,3 et 19,93 mg/100g de matière fraîche contre 3,86 et 12,62 mg/100g pour les mâles. La teneur en Mg maximale est de 14,34 mg/100g pour les femelles du mulet contre 9,97mg/100g pour les mâles de la même espèce. La teneur en sodium est de 48,62 mg/100g pour les femelles contre 20,49 mg/100g pour les mâles du gobie. La teneur en K est de 117,69 mg/100g pour les femelles du gobie contre 51,64 mg/100g pour les mâles. Pour les éléments minéraux mineurs le fer présente une teneur égale à 0,11 mg/100g chez les femelles contre 0,09 mg/100g pour les mâles du sparaillon. Pour les deux sexes analysés, on observe une richesse des femelles en éléments majeurs surtout pour le sparaillon, le gobie et le saurel. L'inverse est observé pour le mulet. Pour le cuivre, le cadmium et le plomb les teneurs obtenues dans la chair des quatre espèces de poissons sont en traces. Ce résultat est concordant avec celui de [2] et [3] obtenu pour les poissons de la mer noire. Pour le zinc les mâles du sparaillon présentent la valeur la plus élevée avec une teneur égale à 0,18 mg/100g. Le zinc est un élément essentiel dans le métabolisme humain [4], ainsi le sparaillon présente une source riche en cet élément.

Conclusion
Les éléments minéraux majeurs sont les plus abondantes dans la chair des poissons, ce résultat est en accord avec [5], avec des teneurs plus élevées chez les femelles et ceci pour toutes les espèces étudiées. Le sparaillon et le gobie sont les espèces les plus riches en ces éléments alors que le saurel est le plus pauvre. Les teneurs en Pb, Cd et en Cu sont faibles dans la chair indiquant que la consommation de ces poissons ne présente pas un danger. La même conclusion est mentionnée par [6] avec les mulets de la lagune ghar el melh (Tunisie).

References
1 - AOAC., 1984. Official Methods of analysis Washington, DC, Association of official Analytical Chemists.
2 - Guner S., Dincer B., Alemdag N, Colak A. et Tufekci M., 1998. Proximate Composition and Selected Mineral Content of Commercially Important Fish Species from the Black Sea. J Sci Food Agric 78, 337È342
3 - Burch R.E., Kahn K. et Sullivan J.F.,1975.Newer aspects of the roles of zinc, manganese and copper in human nutrition. Clin Chem 21 501È520.
4 - Mertz W.,1987. Trace Elements in Human and Animal Nutrition (Vols 1 and 2). Academic Press, San Diego.
5 - Karakoltsidis P A., Zotos A. et Constantinides S M., 1995. Composition of the commercially important Mediterranean Finfish, crustaceans and molluscs. *Journal Of Food composition and analysis* 8, 258-273.
6 - Chouba L., Kraiem M., Njimi W., Tissaoui C.H., Thompson J.R. et Flower RJ., 2007. Seasonal variation of heavy metals (Cd, Pb and Hg) in sediments and in mullet, Mugil cephalus (Mugilidae), from the Ghar El Melh Lagoon (Tunisia). Transitional Waters Bulletin 4, 45-52.

SEASONAL VARIATION OF THE GLOBAL CHEMICAL COMPOSITION OF FISH: ANNULAR SEA BREAM *DIPLODUS ANNULARIS* (L, 1758)

Ilhem Ketata Khitouni [1]*, Abderrahmen Bouain [1], Abdelwaheb Abdelmouleh [2] and Nourhène Boudhrioua Mihoubi [3]
[1] Laboratoire de Biologie Animale, Faculté des Sciences de Sfax B. P. 802, Tunisie - ilhem_ketata@yahoo.fr
[2] Laboratoire de Biotechnologie, Institut National des Sciences et Technologies de la Mer –Sfax, Tunisie
[3] Groupe des Procédés Agroalimentaires, Ecole Nationale des Ingénieurs de Sfax, BP 1173, 3038, Sfax, Tunisie

Abstract
Seasonal variation of the global chemical composition of the annular sea bream species of the coastal catch fish of the Gulf of Gabes (Tunisia) was studied between October 2007 and September 2008. The period of reproduction of *Diplodus annularis* occurs from April to June. This sexual maturity (RGS, RHS) is in strong correlation with the fat content. The fat content is negatively correlated with moisture content R= 0.83, $P<10^{-3}$). The variance analysis of moisture, protein, fat and ash in the whole muscle shows that only the factor months has significant effect on the muscles chemical composition ($P<10^{-3}$).
Keywords: Chemical Analysis, Fishes, Coastal Engineering

Introduction
The period of reproduction of the annular sea bream occurs from February to September. The size of Diplodus annularis at the first sexual maturity is equal for both sexes to 10.21 cm [1]. The aim of the present study is to report an assessment of the global seasonal chemical composition (moisture, protein, fat and ash) of the principal costal catch fish species of the gulf of Gabes and to determine the factors influencing chemical composition. Material and Methods The muscle of fish is divided in two parts: latero-dorsal and latero-ventral parts, whole muscle and organs (liver, Head, gonads, viscera). The gonado-somatic (GSI) and the hepato-somatic (HIS) indexes were calculated as follows: GSI= (Wg/Wev).100,HIS=(Wh/Wev).100, where Wg is the gonad weight and Wev is the eviscerated fish weight. Wh is the liver weight. Moisture content, Crude protein, Fat and Ash are determined. All statistical analysis were performed by using SPSS software® version 11.0 (Statistical Package for Social Sciences). Every factor presenting a p-value (p) inferior to 0.05 was considered significant.

Results
Figure 1 shows the comparison between the gonado-somatic and the hepato-somatic indexes, and the fat content.

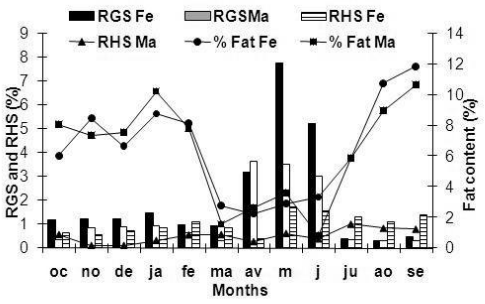


Fig. 1. Comparison between thegonado-somatic and the hepato-somatic indexes, and the fat content.

The gonado-somatic and hepato-somatic indexes of annular sea bream female's present maximal values in May (RGS = 7.73 % and RHS = 1.73 %), and minimal values in April (RGS=0.30) and in Aout (RHS=0.37). The RGS and RHS values are inferior for males than females. The maximal of fat content coincides with the chute of RGS and RHS values from March to July. The maximal of fat content is observed in september and is accompagned with a minimal RGS values. The minimal of fat content corresponds to the highst value of RGS. Strongest negative correlation is shows between fat and moisture contents (R=-0.83 ; p<10-3). Moisture, fat and ash contents varied significantly as a function of month (p<0.001). Whereas the sex of the fish did not have any significant effect on the variation of the moisture, fat, protein and ash contents of the organs (p = 0.83 for the sex). The month haven't a significant effect on the protein content (p=.0.45).

Discussion
According to the classification of fishes [2] based on their fat content, Annular sea bream could be considered as high fat fish categories » 5 to 25 % (g fat/ 100 g fresh fish). In the state of sexual maturity, the size of gonads increases and the fat content of muscle decreased. So the fishes use their muscle fat reserve for the maturation of gonads. After the spawning period, the fat content increases due to the conversion of the gonad tissue. Moisture content is usually inversely related to fat content [3]. This relationship has been observed generally in pelagic ?sh, which lay down oil in the muscle tissue [4], and it could be a consequence of the ?sh maintaining constant density. The effect of sex on the chemical composition was not significant (P<10-3). Whereas the effect of month is significant for moisture, fat and ash content of the muscle.

Conclusion
The seasonal variation of the fat content is inversely correlated to the RGS index. In fact, the maximal of fat content reached in September (11.47 for males and 10.76 for females) coincides with the minimal value of RGS index. Fat and moisture contents are negatively correlated. The effect of sex on the global chemical composition of the annular sea bream is not significant.

References
1 - FAO, 1973. Fiches FAO d'identification des espèces pour les besoins de la pêche méditerranée et mer noire.
2 - Boyer J., Frentz J., Michaud C. and Aubert H., 1995. La charcuterie de poisson et des fruits de mer. *Les publications de Québec-ISBN* 2-551-16189-4.
3 - Grigorakis K. Alexis M. N. Taylor K. D. A., and Hole M., 2002. Comparison of wild and cultured gilthead sea bream (Sparus aurata); composition, appearance and seasonal variations. *International Journal of Food Science and Technology*, 37(5), 477–484.
4 - Love., 1970. *The chemical Biologie of Fishes.* Academic Press, London.

RADIOACTIVITY CONCENTRATIONS IN THE SURFACE SEDIMENT AND MUSSEL SAMPLES FROM THE BOSPHORUS AND THE GOLDEN HORN, TURKEY

Ö. Kiliç [1]*, M. Belivermis [1], S. Topcuoglu [1], Y. Çotuk [1], A. Ugur [2] and B. Özden [2]
[1] Istanbul University, Science Faculty, Biology Department - kilic_onder@yahoo.com
[2] Ege University, Institute of Nuclear Sciences

Abstract
It is well known that sediment and mussel samples are commonly used for monitoring of radioactivity levels in marine ecosystem. In the present study, radioactivity concentrations of ^{137}Cs, ^{40}K, ^{232}Th, ^{238}U and ^{210}Po were measured in sediment and mussel (*Mytilus galloprovincialis*) samples. The results of the present study were compared with the similar studies.
Keywords: Bosphorus, Mollusca, Radionuclides, Sediments

Introduction
Nowadays, the natural radioactivity levels in Turkish marine environment are gradually increased by the fossil fuel industry, phosphate industry and the using of fertilizers. On the other hand, anthropogenic radionuclides are decreased in the biota samples of the Turkish marine environment in the course of time [1]. Some papers have been published concerning anthropogenic and natural radionuclides in biota and sediment samples collected from the Bosphorus strait [2, 3].

Materials and Methods

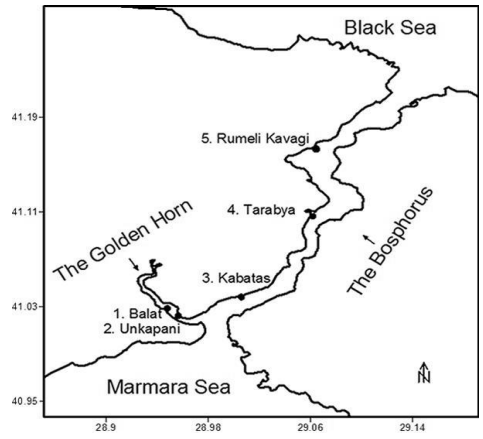


Fig. 1. Study area and sampling stations

The surface sediment samples were collected using a Van Veen grab sampler in the stations. The size fractions (< 63 and > 63 µm) of each sediment samples were dried at 85 ^{0}C to constant weight and homogenized prior to analysis. The mussel samples were cleaned any external material, dissected and then dried at 85 ^{0}C to constant weight and homogenized. The measurements of ^{232}Th, ^{238}U, ^{40}K and ^{137}Cs activities were carried out using a gamma multichannel analyzer equipped with a HPGe detector (Canberra 2020). The concentrations of ^{210}Po in the samples were measured with an alpha spectrometer. Other procedures of the two methods were similar to that previously described [4, 5].

Results and Discussion

^{210}Po concentrations were not measured for the >63 µm fraction of sediment samples in all stations. In Balat station, >63 µm fraction of sediment could not be obtained for radioactivity measurements. ^{137}Cs concentrations in the mussels collected from the sampling stations were generally found to be at the similar level. The activity concentrations in mussel samples of the Bosphorus are slightly lower when compared with that of the previous study carried out in the same site during the period of 2004-2006 [6]. In a previous study, ^{137}Cs activity content significantly increased with the decreasing grain size [7]. ^{137}Cs concentrations determined in the <63 µm sediment fraction in the Bosphorus are significantly higher than those previously reported in this region [2, 4]. On the other hand, ^{137}Cs activity levels are significantly lower in the Bosphorus and the Golden Horn when compared with the eastern Black Sea sediment at the similar grain size.

Tab. 1. Average radionuclide concentrations (Bq kg^{-1} dry weight) in sediment and mussel samples of all sampling stations.

	Sampling Stations	^{137}Cs	^{40}K	^{232}Th	^{238}U	^{210}Po
Sediment>63µm	Balat	-	-	-	-	-
	Unkapanı	5.05 ± 0.29	355 ± 18	12.4 ± 0.7	14.1 ± 0.8	-
	Kabataş	5.30 ± 0.30	382 ± 19	18.1 ± 1.0	19.3 ± 1.0	-
	Tarabya	1.61 ± 0.13	344 ± 17	10.7 ± 0.6	7.9 ± 0.4	-
	Rumeli Kavağı	27.50 ± 1.40	639 ± 32	12.0 ± 0.7	11.6 ± 0.7	-
Sediment<63µm	Balat	40.5 ± 2.2	501 ± 26	22.0 ± 0.9	16.5 ± 0.8	113 ± 7
	Unkapanı	33.4 ± 1.9	410 ± 22	20.9 ± 0.9	15.5 ± 0.9	230 ± 11
	Kabataş	14.9 ± 1.0	341 ± 19	20.0 ± 0.9	16.9 ± 0.8	63 ± 5
	Tarabya	35.7 ± 2.3	493 ± 26	29.2 ± 1.3	20.5 ± 1.2	128 ± 7
	Rumeli Kavağı	46.0 ± 2.6	630 ± 33	14.8 ± 0.7	10.8 ± 0.7	49 ± 3
Mussel	Balat	1.05 ± 0.23	348 ± 18	0.8 ± 0.06	<LLD	65 ± 4
	Unkapanı	1.35 ± 0.20	352 ± 18	0.9 ± 0.05	<LLD	42 ± 4
	Kabataş	1.23 ± 0.18	330 ± 17	2.3 ± 0.12	0.7 ± 0.07	87 ± 7
	Tarabya	1.31 ± 0.26	310 ± 16	1.9 ± 0.10	0.9 ± 0.09	142 ± 15
	Rumeli Kavağı	1.20 ± 0.25	304 ± 16	1.4 ± 0.08	<LLD	166 ± 17

LLD, Lower limit of detection

The highest concentrations of ^{210}Po in mussel and sediment samples were found as 166±17 and 230±11 Bq kg^{-1} in R. Kavagi and Unkapani stations, respectively. ^{210}Po activity concentration in the R. Kavagi mussel has not changed significantly during the past ten years [3]. On the other hand, ^{210}Po level in the Golden Horn sediment is higher than the Black Sea sediment [1].

References
1 - Topcuoglu, S., 2000. Black Sea ecology, pollution research in Turkey of the marine environment. *IAEA Bull*., 42 (4): 12-14.
2 - Topcuoglu, S., Güngör, N., 1999. Radionuclide concentrations in macroalgae and sediment samples from the Bosphorus. Turkish, *J. Mar. Sci*., 5: 19-24.
3 - Güngör, N., Topcuoglu, S., 2001. ^{210}Po and ^{210}Pb concenrations in biota from the Turkish coast of the Black Sea and Marmara Sea. Rapp. Comm. Int. Mer Médit., 36, 132.
4 - Topcuoglu, S., Kut, D., Esen, N., Güngör, N., Ölmez Egilli E., Kirbssoglu, Ç., 2001. ^{127}Cs in biota and sediment samples from Turkish coast of the Black Sea, 1997-1998. *J. Radional. Nucl. Chem*., 250 (2): 381-384.
5 - Ugur, A.,Yener, G. Bassari, A., 2002. Trace metals and ^{210}Po/^{210}Pb concentrations in mussels (*Mytilus galloprovincialis*) consumed at western Anatolia. App. Radiat. Isot., 57: 565-571.
6 - Thébault, H., Baena, A.M.R., Andral, B., Barisic, D., Albaladejo, J.B., Bologa, A., Boudjenoun, R.,Delfanti, R., Egorov, V.N., Khoukhi, T. El., Florou, H., Kniewald, G., Noureddine, A., Patrascu, V., Pham, M.K., Scarpato, A., Stokozov, N.A., Topcuoglu, S., Warnau, M., 2008. ^{137}Cs baseline levels in Mediterranean and Black Sea: A cross-basin survey of the CIESM Mediterranean mussel watch programme. *Mar. Pol. Bull*., 57: 801-806.
7 - Topcuoglu, S., Ergül, H.A., Baysal, E., Ölmez, E., Kut, D. 2003,. Determination of radionuclide and heavy metal concentrations in biota and sediment samples from Pazar and Rize stations in the eastern Black Sea. *Fre. Environ. Bull.*, 12 (7): 695-699.

VARIATION SAISONNIERE DES TENEURS EN ELEMENTS MINERAUX ET EN METAUX LOURDS DE QUATRE ESPECES DE POISSONS DU GOLFE DE GABES

Aida Koubaa [1]*, Nourhene Boudhrioua [2], Abdelwaheb Abdelmouleh [3] and Abderrahmen Bouain [1]
[1] Faculté des Sciences de Sfax - aydakoubaa@yahoo.fr
[2] Institut National des Sciences et Technologies de la Mer Sfax-Tunisie
[3] Groupe des Procédés Agroalimentaires, Ecole Nationale des Ingénieurs de Sfax- (Tunisie)

Abstract
L'étude de la variation saisonnière des teneurs en éléments minéraux et en métaux lourds (mg / 100g frais) de quatre espèces de poissons du golfe de Gabès, révèle qu'ils sont riches en éléments majeurs (calcium : 35,122-102,987, potassium : 179,474-309,447 et sodium : 105,154- 179,788). Les teneurs en magnésium (44,402-80,324), en fer (16,123-22,628) sont plus faibles. Celles en zinc (0,489-1,622) et en cuivre (0,096-0,646) sont très faibles. Le cadmium (<0,04) et le plomb (0,076) sont présents en traces. L'analyse statistique montre que la saison et les espèces présentent des effets significatifs (p<0,05) sur les concentrations de quelques éléments minéraux.
Keywords: Analytical Methods, Chemical Analysis, Fishes, Gulf Of Gabes

Introduction
Les métaux lourds qui sont continuellement déchargés dans les écosystèmes aquatiques contribuent à la pollution de la mer. Les poissons peuvent être considérés comme des indicateurs les plus significatifs pour l'évaluation du niveau de pollution en métaux. Plusieurs espèces commerciales et comestibles ont été largement étudiées afin de déterminer leurs teneurs en éléments minéraux et en métaux lourds. L'objectif de cette étude est de déterminer la variation saisonnière des teneurs en éléments minéraux et en métaux lourds du rouget de vase (*Mullus barbatus*), rouget de roche (Mullus surmuletus), marbré (*Lithognatus mormyrus*) et pageot (*Pagellus erythrinus*) du golfe de Gabès.

Matériel et méthodes
L'échantillonnage des poissons a été réalisé durant l'année 2007-2008 par le chalut du golfe de Gabès. Au laboratoire, les échantillons de poisson frais ont été pesés puis éviscérés. Après éviscération, la chair des mâles et des femelles est analysée séparément. Les échantillons frais ont été déshydratés dans une étuve réglée à une température de 105°C jusqu'à poids constant. L'extrait sec obtenu a été calciné dans un four à moufle à 550 - 600°C pendant 3 heures. Les teneurs en éléments minéraux et en métaux lourds ont été dosés par spectrophotométrie d'absorption atomique (type Hitachi Z 6100) [1]. Une analyse de variance et une analyse en composante principale ont été appliquées pour étudier l'effet des facteurs (saison, espèce et sexe) sur les concentrations en éléments minéraux et les répartirent en différents groupes à l'aide du logiciel SPSS (15.0) (Statistical Package for Social Sciences).

Résultats et discussion
Les concentrations des éléments minéraux et des métaux lourds dans la chair du poisson sont dépendantes des saisons et des espèces étudiées. Les valeurs des teneurs en Ca, Na, K, Mg, Fer, Zn, Cu, Cd et Pb pour les deux saisons (printemps et été) et pour les espèces étudiées sont consignées dans le tableau 1.

Tab. 1. Composition en élements mineraux et en métaux lourds des espèces étudiées (teneur en mg/100g de chair de poisson frais)

	Rouget de vase		Rouget de roche		Marbré		Pageot	
	Avril	Juillet	Avril	Juillet	Avril	Juillet	Avril	Juillet
Ca	64,342 ±0,001	35,122 ±0,001	63,777 ±0,002	44,111 ±0,002	97,518 ±0,003	45,155 ±0,003	102,987 ±0,001	59,915 ±0,002
Na	126,145 ±0,001	179,788 ±0,003	150,499 ±0,002	132,403 ±0,002	131,464 ±0,002	118,129 ±0,002	105,154 ±0,001	126,614 ±0,003
K	262,989 ±0,003	224,956 ±0,002	290,223 ±0,002	179,474 ±0,002	309,446 ±0,002	211,465 ±0,001	260,656 ±0,001	217,621 ±0,001
Mg	44,402 ±0,002	68,065 ±0,002	47,351 ±0,003	80,324 ±0,001	50,163 ±0,001	65,364 ±0,003	46,544 ±0,002	57,398 ±0,001
Fer	17,574 ±0,002	22,628 ±0,003	19,908 ±0,002	22,618 ±0,002	16,122 ±0,002	19,308 ±0,002	16,576 ±0,001	19,823 ±0,001
Zn	0,498 ±0,001	0,678 ±0,001	0,508 ±0,003	0,615 ±0,001	1,283 ±0,003	1,622 ±0,002	0,548 ±0,002	0,837 ±0,002
Cu	0,096 ±0,002	0,258 ±0,002	0,113 ±0,002	0,312 ±0,003	0,095 ±0,003	0,646 ±0,003	0,110 ±0,001	0,353 ±0,001
Cd	<0,014 ±0,002	<0,040 ±0,002	<0,016 ±0,002	<0,038 ±0,002	<0,013 ±0,002	<0,035 ±0,001	<0,014 ±0,002	<0,034 ±0,002
Pb	<0,033 ±0,002	<0,076 ±0,002	<0,038 ±0,003	<0,073 ±0,003	<0,024 ±0,002	<0,068 ±0,002	<0,031 ±0,002	<0,065 ±0,001

Les valeurs minimales de Ca et K ont été obtenues en été, alors que pour les autres éléments minéraux (Na, Mg, Fer et Zn) et les métaux lourds (Cu, Cd et Pb), les teneurs maximales sont obtenues en été. L'analyse de variance montre que les éléments minéraux et les métaux lourds (potassium, calcium, magnésium, fer et cuivre) différent significativement d'une saison à une autre pour les quatre espèces et sexe confondues (p<0,05). L'ANOVA de l'analyse des deux saisons ensemble, révèle que seul le zinc (Zn) varie significativement (p<0,05) selon les quatre espèces étudiées. Le sexe n'a pas d'effet significatif (p>0,05). Sur tous les échantillons analysés, pour la saison de printemps, les espèces influent seulement sur les teneurs en Ca, K, Fer et Zn (p<0,05). En été les concentrations en Ca, Na et Zn différent significativement selon les espèces (p<0,05). Cette dernière constatation est bien confirmée par l'Analyse en Composantes Principales (ACP). En effet, le calcium, le sodium, le zinc, le magnésium, le fer et le cuivre définissent l'axe 1 qui représente 47,38 % de la variance totale. La variable potassium détermine l'axe 2 qui représente 23,43 % de la contribution totale qui est 70,818 % (figure 1).

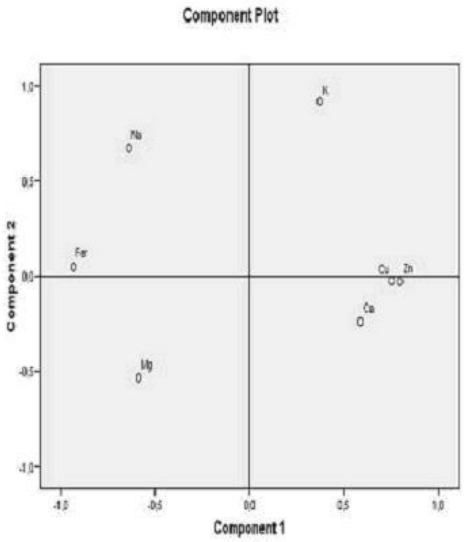


Fig. 1. Analyse en Composantes Principales des éléments minéraux des espèces des poissons étudiés en été.

References
1 - AOAC., 1971. Sodium and Potassium in seafood flame photometric method. *In* Fish and other marine products. Gershman, Louis L., 54: 18.038 – 18.042.

VARIATION SAISONNIERE DES TENEURS EN EAU ET EN LIPIDES ET DE LA COMPOSITION DES ACIDES GRAS DU ROUGET DE ROCHE (*MULLUS SURMULETUS*) DU GOLFE DE GABES

Aida Koubaa [1]*, Abdelwaheb Abdelmouleh [2], Abderrahmen Bouain [1] and Nourhène Boudhrioua [1]
[1] Faculté des Sciences de Sfax, 3018, Tunisie - aydakoubaa@yahoo.fr
[2] Institut National des Sciences et Technologie de la Mer, 3018, Sfax, Tunisie

Abstract
Les teneurs en eau et en lipides des rougets de roche présentent une large fluctuation durant toute l'année. Le maximum de la teneur en lipides est atteint au mois de novembre (10,886 %) et le minimum est atteint au mois de mai (2,92 %). Durant toute l'année, la teneur en eau est inversement proportionnelle à celle en lipides. Le spectre des acides gras montre une richesse relative en acides gras polyinsaturés (l'acide linoléique, l'acide arachidonique et l'acide docosahexaenoique). Les concentrations des acides gras saturés et mono insaturés sont plus élevées pendant le printemps que l'hiver, le cas contraire est observé pour les acides gras polyinsaturés.
Keywords: Analytical Methods, Biotechnologies, Chemical Analysis, Fishes

Introduction
La Tunisie est un grand producteur et exportateur de fruits de mer. Le secteur de la pêche a une grande importance économique, sociale et même environnementale. Les fruits de mer de la Tunisie incluent les mollusques, les crustacés, les poissons, etc. Plusieurs modes de pêche sont pratiqués en Tunisie, parmi lesquels on cite la pêche au chalut. L'apport national de ce mode de pêche a augmenté de 12 % entre les années 2007 et 2008 [1]. Le rouget de roche est une espèce benthique à haute valeur commerciale et très consommée en Tunisie ; elle est pêchée au chalut. C'est une espèce grasse, riche en acides gras polyinsaturés. De nombreuses études ont montré que l'huile de poissons a plusieurs bienfaits pour la santé comme la réduction des maladies cardio-vasculaires [2]. Ce travail porte sur l'étude de la variation saisonnière de la teneur en eau et en lipides et de la composition des acides gras du rouget de roche du golfe de Gabès.

Matériel et méthodes
La capture des poissons a été réalisée à l'aide d'un chalut dans le golfe de Gabès. La variation de la teneur en eau, en lipides et en acides gras a été déterminée durant l'année 2008-2009. Les analyses ont été effectuées sur la chair de poissons frais. Pour la détermination de la teneur en eau, les échantillons ont été déshydratés dans une étuve réglée à une température de 105°C jusqu'à poids constant [3]. La teneur en lipides a été analysée par la méthode de Soxhelt en utilisant le chloroforme comme solvant d'extraction. Les acides gras ont été extraits selon le procédé de Bligh et Dyer [4], après méthylation, les esters méthyliques ont été analysés par CPG-SM (type ATTUMICAM 610).

Résultats et discussion
L'analyse de la teneur en lipides révèle qu'elle est très variable. En effet, la réserve lipidique est totalement épuisée pendant le mois de mai, les valeurs de la teneur de lipides chutent de 8,1 % (avril) à 2,92 % (mai). Durant cette période le poisson utilise beaucoup d'énergie : c'est la période de ponte. Contrairement à la teneur en lipides, la teneur en eau subit une diminution pendant les mois (octobre et novembre) et une augmentation pendant le mois de mai (figure 1).
Pour les mâles et les femelles de cette espèce, durant toute l'année, les lipides sont formés par les proportions suivantes des acides gras totaux (20 à 30 % saturés, 15 à 45 % mono insaturés et 15 à 60 % polyinsaturés). En ce qui concerne leur variation, les poissons capturés au printemps présentent une concentration plus élevée d'acides gras saturés et mono insaturés (tels que l'acide palmitique : C16:0, l'acide stéarique : C18:0, l'acide palimtoléique : C16:1n-9, et l'acide oléique : C18:1n-9) et une concentration moins élevée d'acides gras polyinsaturés essentiellement l'acide linoléique (C18:2 n-6), l'acide arachidonique (C20:4 n-6) et l'acide docosahexaenoique (C22:6 n-3) que ceux capturés en hiver.

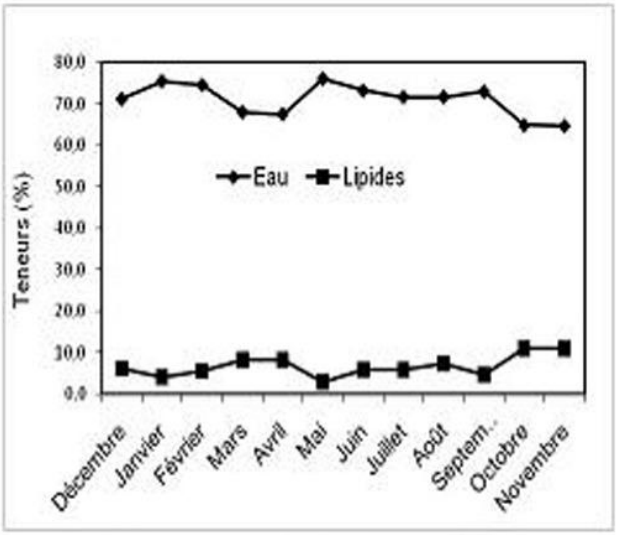


Fig. 1. Variations saisonnières des teneurs en eau et en lipides chez le rouget de roche femelle

References
1 - DGPA., 2008. Annuaires des statistiques des produits de la pêche. Direction Générale de la pêche et de l'Aquaculture. Ministère de l'Agriculture. Tunisie.
2 - Mozaffarian D., Geelen A. Brouwer I.A., Geleijnse J.M.,Zock P.L. and Katan M.B., 2005. Effect of fish oil on heart rate in humans : a meat-analysis of randomised controlled trials. *Circulation.*, 112: 1945-1953.
3 - AOAC (Association of Official Analytical Chemists)., 1990. *Official methods of analysis.*Washington.DC.
4 - BlighE.G. and DyerW.J., 1959. A rapid method for total lipid extraction and purification .*Can.J.Biochem.Physiol*., 37: 911-917.

PETOLA-STROMATOLITIC BASEMENT FOR MANUAL GATHERING OF SALT IN SECOVLJE SALINA

Nives Kovac [1]*, Neli Glavaš [1] and Boris Šket [2]
[1] national institute of biology (marine biology station) - kovac@mbss.org
[2] Faculty of Chemistry and Chemical Technology, University of Ljubljana, Askerceva 5, 1000 Ljubljana, Slovenia

Abstract
In Secovlje Salina (Gulf of Trieste, northern Adriatic), the stromatolitic microbial mat named "petola" is a crucial element in old mediaeval manner of salt-production so the understanding of its chemistry is very important for the preservation and progress of this activity. The chemical study (FT-IR, ^{13}C-NMR, elemental analyses) was performed to investigate the petola composition and its transformations during salt-making processes
Keywords: Salinity, Mineralogy, Adriatic Sea

Introduction
In Secovlje solar salterns (northern Adriatic, Slovenia) the salt is still produced with traditional procedures by manual gathering of salt on the petola i.e. microalgal mat composed mostly of cyanobacteria, diatoms and other microalgae impregnated with minerals (gypsum, Mg-calcite…). Petola prevents sea mud from mixing with salt so this naturally produced salt is rich in minerals and purely white. This biological-chemical facet has a special role in the precipitation/dissolution processes so the understanding of its chemistry is very important for the preservation and progress of this activity. The presented results upgrades the previous chemical study of petola samples from 2006 [1].

Materials and methods
Sampling was carried out in the crystallizer pond on May 14th (Sample A), June 9th (Sample B), and July 30th (Sample C), in 2009. Surficial sediment samples (0-2 cm) were collected using 40 mm diameter gravity core sampler and then the tiny slice of surface sediment i.e. 2-3 millimeter thick layer of biosediment was cut offand frozen. The freeze-dried samples were grounded to a fine powder and used for elemental, ^{13}C-NMR and FT-IR analyses.

Results and discussion
The FT-IR analyses of petola samples (Figure 1) confirmed the fractional crystallization of different salts according to the increasing evaporation and salinity. First to crystallize are carbonates and sadra (brine conc. >13 Bé), followed by NaCl (brine conc. ~25 Bé) and finally magnesium salts (brine conc. >26 Bé) [2]. Unfortunately, the NaCl is transparent to the infrared light and not introduce any lines onto the spectra. The alteration of organic fraction of petola was detected during its maturation and increasing brine salinity concentration. Cementation during petola cultivation contribute to its stabilization and a higher hardnes allowing the manual gathering of salt on this basin's base.

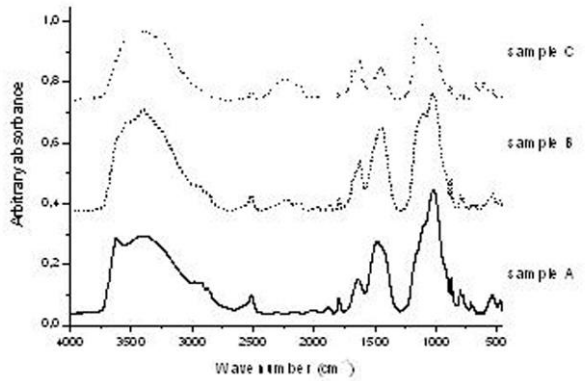


Fig. 1. FT-IR spectra of petola samples (Secovlje Salina)

Major FT-IR spectra bands could be assigned: 3625 cm^{-1} (clay minerals), 3000-3600 cm^{-1} (O-H and N-H stretching band region), 2800-3000 cm^{-1} (organic carbon i.e. CH_2 and CH_3 alkyl groups), 1653-1640 cm^{-1} (proteinic component, water signals, aromatic and olefinic C=C groups), carbonates, (2514, 1795, 1420-1450, 876 and 713 cm^{-1}), silicates (1870, 1160, 1020, 799, 780, 696 and 534 cm^{-1}), sadra (3407, 1683, 1621, 1141, 1118, 669 and 602 cm^{-1}). Evaluation of ^{13}C NMR data will give us further insights into the composition and reactivity of petola organic carbon.

References
1 - Kovac N., 2009. Chemical characterisation of stromatolitic "petola" layer (Secovlje salt-pans, Slovenia) using FT-IR spectroscopy. *Ann, Ser. hist. nat.*, 19: 95-102.
2 - Faganeli J., Pezdic J., Ogorelec B., Dolenec T. and Cermelj B., 1999. Salt works of Secovlje (Gulf of Trieste, northern Adriatic) - a sedimentological and biogeochemical laboratory for evaporitic environments. *RMZ-mater. geoenviron.*, 46: 491-499.

VERTICAL HYDROCHEMICAL STRUCTURE OF THE WESTERN BLACK SEA AREA IN 2007 – 2008 PERIOD

Anton Krastev [1]*, Galina Shtereva [1], Ognyana Hristova [1] and Boryana Dzhurova [1]
[1] Institute of Oceanology - BAS, Varna, Bulgaria - antnkrstv@abv.bg

Abstract
The western part of the Black Sea is highly influenced by major rivers input. Through different periods its vertical hydrochemical structure varies in response of the hydrological conditions and the anthropogenic influence. The study is an attempt to estimate the stability of the chemical parameters content in the water body of the region in two seasons – early spring (cold upper layer waters) and late summer (well expressed termocline).
Keywords: Nutrients, Oxygen, Black Sea, Vertical Profile

Methods
The study is based on data obtained during the seasonal cruises (October 2007 and 2007 and April 2008) with RV "Akademik" in western Black Sea area. The samples are collected from 9 stations using Rosette Seabird system on the following depths: 1, 10, 25, 50, 75 and 100 m, depth of thermocline location and DCM and depths corresponding to σ = 15.0, 15.2, 15.4, 15.8, 16.0 and 16.2. The hydrological parameters are measured by Seabird CTD System. The hydrochemical parameters analyses are accomplished by standard methods [1].

Results
Hydrology. In October the Upper Mixed Layer (UML) is located in the water column beneath surface with temperature 18.5 – 20.3 °C and density (σθ) about 10.5 – 12.2. The thermocline is located in the depth range of 29 – 35 m and the Cold Intermediate Layer (CIL) – in 60 – 100 m. The thermohaline structure in April is typical for early spring without expressed thermocline. The upper surface layer is characterized with low temperature in range 9.3 – 11.2 °C and density 13.0 – 13.9.

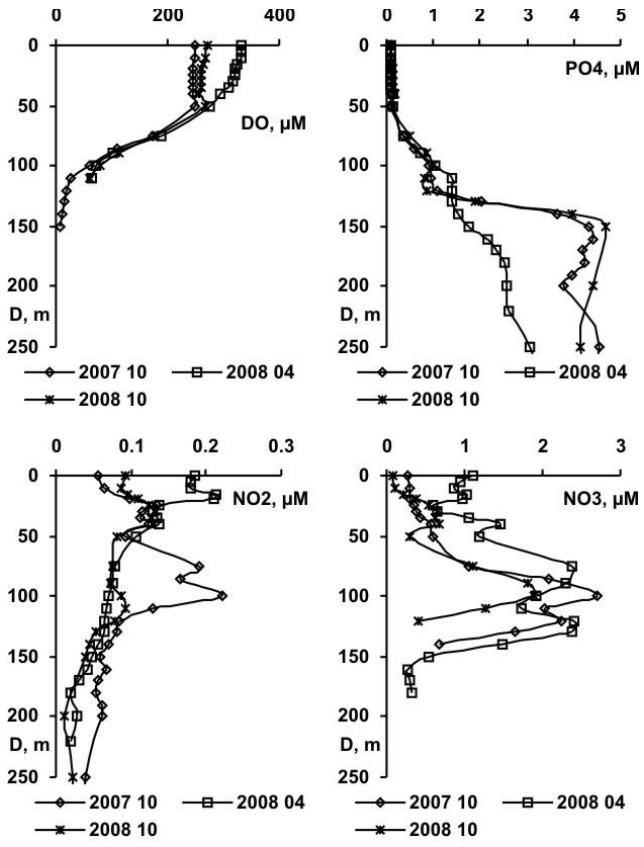


Fig. 1. Filtered vertical distribution of DO, PO4, NO2 and NO3

Dissolved gases. High oxygen content in April (360 µM) (Fig. 1) corresponds to highest Oxygen Saturation (OS) in surface waters due to hydrological conditions. In CIL DO vertical distribution follows the same pattern for each season – decreasing gradient from about 250 µM to the redox zone. H2S is detectable from depths > 120 – 140 m. Its increase becomes steeper below 150 m (σθ > 16.0 – 16.2) (Fig. 1). The depth of the upper anoxic waters could be considered deeper for the distant stations but is not irregular during last decade [2].

Nitrogen. Surface, UML and CIL (oxygenated waters) NH4 concentrations are relatively low (0.5 µM). From σθ = 16.0 (135 – 145 m) its concentrations increase down to the anaerobic zone. NO2 and NO3 concentrations in UML in the end of summer are lower due to biochemical exhaustion and the NO2 maximums in the thermocline and in the oxycline are well expressed (Fig. 1). The maximum NO3 concentrations (~ 96 – 120 m, σθ = 15.4) does not exceed 3 µM, which is less than the values detected during summer (> 5 µM) [3, 4] in the same region. Nitrates disappear at σθ = 16.0 – 16.2 as it has been observed elsewhere [5, 6]. The Total Nitrogen (TN) varies around 10 µM and is its content is relatively higher in April.

Phosphorous. PO4 content is low down to CIL both in warm and cold seasons. In CIL an increase is initiated with an upper maximum of 1.4 µM in April and 0.8 µM in October at σθ = 15.5 and minimum at σθ = 15.9 where the oxycline is located. The second maximum of 4 – 5 µM in the warm season is found at σθ = 16.25 (150 – 160 m) (Fig. 1).

Silicates. SiO2 distribution is characterized by significant increase down to σθ = 16.0 (Fig. 2). In UML its content varies in range 2 – 7 µM. The measured lower concentrations possibly are due to phytoplankton growth during both seasons in the euphotic zone. SiO2 concentration in near shore stations (coastal waters) is 2 times higher than in deep zone surface waters [7].

Suspended matter is higher in the upper layer – 0.7 - 1.0 mg/l and decreases steeply in the beginning of CIL. In thermocline SM is normally lower in the colder season.

Conclusions
– The vertical hydrochemical structure in Western Black Sea is generally specified by the hydrological conditions of the water column;
– The anoxic zone appears relatively low (140 – 150 m), the NH3 distribution, the NO2 specific variations and the NO3 reduction are well expressed, considering undisturbed stratification and hydrochemical stability of the water column in the investigated period;
– PO4 deeper maximum in October is specific for the warm part of year due to mineralization of the increased organic matter;
– The measured surface lower concentrations SiO2 are possibly due to phytoplankton growth during both seasons in the euphotic zone.

Acknowledgements
The study is supported by SESAME Programme and the BAS-RAS joint project – Black Sea Redox Layer Specifics.

References
1 - Grasshoff K., Ehrhard M., Kremling K, 1983. Methods of sea water analyses. 419.
2 - Shtereva G., Krastev A. and Hristova O., 2003. Vertical Distribution of Nutrients in the Western Black Sea Area (summer 1998-2002). Proceedings of 2nd Intern. Conference "Oceanography of Eastern Mediterranean and Black Sea" (Ed. A. Yulmaz), 438 442
3 - Krastev A., Shtereva G., Hristova O., Dzhurova B. 2006. Nutrients In the Western Black Sea Area – Spatial And Vertical Distribution, Proceeding of 1-st Black Sea Conference, "Black Sea Ecosystem 2005 and Beyond" May 2006, Istanbul, (CD)
4 - Yakushev E., Podimov O., Chasovnikov V. 2005. Seasonal changes in the hydrochemical structure of the Black Sea redox zone. *Oceanography*, v.18, 2, 48-55.
5 - Shtereva G., Krastev A., Hristova O., Dzhurova B. 2005. Changes of biogeochemistry in the Bulgarian Black Sea coastal area, *Proceedings of IO*, v.5, 103-111.

POTENTIAL TOLL OF A DESALINATION PLANT: A) SEAWATER QUALITY

Nurit Kress [1]*, Dror Dromi [1] and Yossef Z Yacobi [1]
[1] Israel Oceanographic & Limnological Res, National Institute of Oceanography - nurit@ocean.org.il

Abstract
The potential impact the discharges of brine and backwash (containing the coagulant ferric hydroxide) on seawater quality was monitored at the area of the outfall of a reverse osmosis (RO) desalination plant. Preliminary results showed that water was warmer and more saline at the discharge area, and that the backwash tinted the water red, increased water turbidity and the concentration of suspended particulate matter, the influence reaching up to 1,500m. Nutrient concentrations were also higher at the discharge area and decreased with increased distance. While the effect of the backwash on a few parameters of water quality was obvious, the various discharges in the area make it impossible at this time to attribute a cause-effect to explain the findings of this research.
Keywords: Coastal Waters, Nutrients, Salinity, Monitoring, Levantine Basin

Desalination has increasingly been seen as an important element in dealing with water shortage particularly by countries which border the sea. In Israel, increase in water usage and dry years prompted the government to set a goal of 600,000 million m^3 desalinated water per year by 2013. To date, there are two operational seawater desalination plants at the Mediterranean coast of Israel, producing ca. 140,000 million m^3 water yearly by reverse osmosis, a third plant almost operational (ca. 100,000 million m^3 yearly) and two large plants at the planning stage. However, the impact of pumping large volumes of seawater into the plants and of concentrate discharges from the plants has yet to be fully assessed. Pumping large volumes of seawater into desalination plants can cause impingement and entrainment of organisms, in particular plankton, fish eggs and larvae, and depletion of those organisms. Moreover, ca. 50% of the feedwater is converted to concentrate that is discharged back to the sea. If the desalination plant operates in an area where water quality is already poor, the concentrate will contain also excess of the pollutants present in the seawater intake. In addition, the process of desalination utilizes chemicals in the pre-treatment of seawater entering the plant and during the desalination process such as ferric hydroxyde (coagulant) and polyphosphonates (antiscalants) that are discharged to sea with the desalination concentrate (1). In this work we monitored the effect of the discharge of ferric hydroxide on the water quality at the outfall of a RO desalination plant operating in Ashkelon, at the southern Mediterranean coast of Israel , the largest RO plant in the world. The brine and the backwash of preliminary filtration stage, the latter containing ferric hydroxide, are discharged at the shore, next to the discharge of cooling waters of a power plant adjacent to the RO plant. The brine is discharged continuously while the backwash is discharged in pulses, their frequency depending on the seawater quality of the intake. To complete the picture, brine from well's amelioration, containing nitrates, are also discharged in the same area. Three surveys (April and August 2008 and April 2009) were conducted in the area and seawater samples were collected before, during and after the pulsed discharge of the backwash, along a gradient from the more affected area to apparently clear (non affected) water area. Preliminary results showed that seawater temperature at the outfall area was higher by 4-6 ^oC due to the effect of the power plant cooling water discharges. Salinity was ca. 1% higher than the natural salinity in the area (39.5) due to the brine continuous discharge, it's influence traced up to 500 m from the outfall. Similar results were seen in SE Spain (2). The backwash increased water turbidity and tinted the seawater red as a result of the introduction of suspended particulate matter containing Fe, that increased in concentration from 6 to 14 mg/l. It's influence could be traced as far as 1,500 m from the outfall. The bacterial community was also influenced as described by Yacobi and Kress (Submitted abstract, CIESM 2010). Nutrient concentrations at the discharge area was higher than in the vicinity, in particulate nitrate, probably as a result of well's amelioration brine, with concentration decreasing with increased distance from the discharge area. While the effect of the backwash on water quality (turbidity, particulate matter) was obvious, the various discharges in the area make it impossible at this time to attribute a cause- effect to explain the findings of this research.

References

1 - Desalination, a national perspective., 2008. National Research council of the National Academies. The National academies press, Washington, D.C.
2 - Fernandez-Torquemada, Y., Sanchez-Lizaso, J.L. and Gonzales-Correa, J.M., 2005. Preliminary results of the monitoring of the brine discharge produced by the SWRO desalination plant of Alicante (SE Spain). *Desalination*, 182, 395-402.

UNDERSTANDING WHY NUTRIENT CYCLING IN THE EASTERN MEDITERRANEAN (EMS) IS SO UNUSUAL?

Michael Krom [1]*, Kay-Christian Emeis [2] and Phillippe Van Cappellen [3]
[1] University of Hamburg
[2] Georgia Tech Institute, Atlanta
[3] Earth & Biosphere Institute, School of Earth and Environment, University of Leeds - M.D.Krom@Leeds.ac.uk

Abstract
The high N:P in the EMS is due to high N:P ratio in the external inputs combined with low denitrification caused by its ultra - oligotrophic status. There is no evidence for N-fixation. The external inputs have increased by 2-5 times between 1960 and 2000 and yet there is no evidence of increased primary productivity. We suggest this is due to rapid export of excess nutrients through the Straits of Sicily.
Keywords: Eastern Mediterranean, Phosphorus, Pollution, Geochemical Cycles

The EMS is both P starved and unequivocally phosphorus limited with a nitrate:phosphate ratio in the deep waters of ~28:1 and similar high ratios in the dissolved and particulate organic matter (1). It is also unusual in being ultra-oligotrophic. This is despite the basin being surrounded by land with a resident population of ~ 120 million people and a further 120-200 million tourists yearly. As a result of this large population there are considerable external inputs of nutrients (N & P) from both atmospheric and riverine sources. Recent studies have shown that the high N:P ratio found in the EMS is due to a combination of high N:P ratios in the external inputs combined with low denitrification rates. This is because there are limited areas of anaerobic sediment due the ultra-oligotrophic nature of the basin. A total nutrient budget for the entire basin shows that the external inputs balance closely the outputs (Table 1) without any nitrogen fixation.

Tab. 1. Calculated nutrient inputs into and outputs from the Eastern Mediterranean basin. All values as given in 10^9 moles/y. The data for the total nutrient budget is from Krom et al., (2004) with subsequent data from Ludwig et al., (2009)

Source	N input/	P input/	Molar N:P
Atmospheric input (1996-1999)	111	0.95	117
Riverine input	63	2.4	26.3
Black sea	8	0	-
Total inputs to basin	**180**	**3.4**	**54**
Straits of Sicily	142	4.4	32
Sediment deposition	27	1.0	27
Sediment denitrification	10	-	-
Total output from basin	**179**	**5.4**	**33**
Atmospheric input (1960)	50.5	-	
Atmospheric input (1996-1999)	111	0.95	117
Riverine input (1963)	10.8	0.51	21.2
Riverine input (1998)	51.0	1.04	49.2

A similar budget for the core of the Cyprus eddy found that the annual inputs of fixed nitrogen into the core of the eddy balanced by known exports (2). Both budgets were in balance without any significant nitrogen fixation. Previous explanations for the observed isotopically light $\delta^{15}N\text{-}NO_3$ (2.4± 0.1‰) in the deep water which suggested extensive nitrogen fixation did not take into account the isotopic signature of the atmospheric input. Recent measurements have shown that this external input is isotopically light ($\delta^{15}N$ = -3.1‰) and together with the known atmospheric N flux is able to explain the isotopic content of nitrate in the deep water without any nitrogen fixation (5) Direct measurements of nitrogen fixation across the EMS have found rates at or below detection limits; (0.5-2 µmol/m^2/d; and ~1 nmol/l/d;. The exceptionally high nitrogen fixation rates in the Cyprus eddy (3) (129 nmol/l/d; 15 mmol/m^2/d) are considered anomalous particularly since the only potential diazotroph observed within the system at the time of measurement were *Synechococcus sp.* and these were found in low numbers (3.3-4.3 x 10^6 cells/l;. This explanation for the unusual N:P ratio in the EMS is entirely compatible with existing explanations for the global controls of the Redfield ratio as being a balance between denitrification removing N to below 16:1 and subsequent N fixation adding fixed nitrogen. The EMS is simply unusual because there is almost no denitrification, even in the coastal sediments.

The low nutrient concentrations in the deeper water in the EMS, which is the cause of the observed ultra-oligotrophic conditions, is due to the anti-estuarine circulation with low nutrients being supplied by the in-flowing surface waters and significant nutrient export in the outflowing intermediate water. The external flux of fixed nitrogen in the atmospheric supply has increased by a factor of 2.2 since 1960 while the riverine flux has increased by a factor of 4.5 during the same time period (Table 1). The riverine P flux has also increased by a factor of ~2 (4). Despite these major increases in external nutrient flux, there is no evidence of a parallel increase in primary productivity or any other regional measure of eutrophication. We propose that this is because the nutrients are exported with the outflow at the Straits of Sicily with nutrients having a residence time of only <10 years in the EMS. These new understandings have important implications on our understanding of biogeochemical cycles within the EMS basin and need to be taken into account in any attempts to predict the effect of changing nutrient fluxes or ocean acidification on this sensitive ecosystem.

References
1 - Krom, M.D., Herut, B., Mantoura, R.F.C., 2004. Nutrient budget for the eastern Mediterranean: Implications for P limitation. *Limnol. Oceanogr.*, 49: 1582-1592.
2 - Krom, M.D., et al ., 2005. Nutrient cycling in the south east Levantine basin of the Eastern Mediterranean: results from a phosphorus starved system. *Deep-Sea Res. II*, 52: Nos 22-23 2879-2896.
3 - Rees, A.P., Law, C.S., Woodward, E.M.S., 2006. High rates of nitrogen fixation during an in-situ release experiment in the Eastern Mediterranean sea. *Geophys. Res. Letters*, 33: L10607.
4 - Ludwig, W., Dumont, E., Meybeck, M., Heussner, S., 2009. River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers of ecosystem changes during past and future decades? *Progress in Oceanography* 80: 199-217.
5 - Mara. P., Mihalopoulos, N., Gogou, A., Daehnke, K., Schlarbaum, T., Emeis, K.-C., Krom, M.D., 2009. Isotopic composition of nitrate in wet and dry atmospheric deposition on Crete/ Eastern Mediterranean Sea. Global Biogeochemical Cycles.

EVALUATION OF HEAVY METAL POLLUTION IN SEDIMENT AND *MULLUS BARBATUS* FROM THE IZMIR BAY (EASTERN AEGEAN) DURING 1997-2009

Filiz Kucuksezgin [1]*, Aynur Kontas [1] and Esin Uluturhan [1]
[1] Dokuz Eylul University Institute of Marine Sciences & Technology - filiz.ksezgin@deu.edu.tr

Abstract
Izmir Bay (western Turkey) is one of the great natural bays of the Mediterranean. Outer and middle bays show low levels of heavy metal enrichments except estuary of Gediz River. Heavy metal levels were lower than the results in fish tissues reported from polluted areas of the Mediterranean Sea.
Keywords: Metals, Sediments, Fishes

Introduction
Izmir is an important industrial and commercial centre and a cultural focal point. The Gediz River, which flows to the northern part of the bay, is the second biggest river along the eastern Aegean coast. Gediz River is densely populated and includes extensive agricultural lands and numerous manufacturing, food and chemical industries. A number of studies have been carried out on the concentrations of nutrients and heavy metals in the bay during a year, but no long-term and seasonal data are available. The main aim of this study was to monitor levels, temporal variability and distribution of heavy metals in edible fishes and sediments of Izmir Bay.

Materials and Methods
The study area located between the longitudes 26°30'-27°08' E and latitudes 38°41'-38°21' N. Sediment and fish samples were analysed according to UNEP [1,2,3]. Sediment (SD-MEDPOL-1/TM) and fish (MA-MEDPOL-1/TM) samples were used as a control for the analytical methods.

Results and Discussion
The highest concentrations of metals were found in sediments from the inner part of the bay where intensely industrialized (mainly iron, paper and pulp factories, antifouling paints, chlorine-alkali plants, chemical industries, textile industries, metal processing, timber processing, cement factories, food processing, beverage manufacturing and bottling, tanneries, oil, soap and a very busy harbour) compared to the middle and outer parts of the bay. The concentrations of Cd, Cu and Pb in the outer bay were generally similar to the background levels and mean concentrations from the Mediterranean and Aegean Seas except chromium, zinc and mercury. ANCOVA was used to compare the regional differences in the heavy metal concentrations of sediments. In consequences, the comparison of metal concentrations demonstrate that, there are significant ($p<0.05$) regional variations. *M. barbatus*, being bottom dwellers to a certain extent, are species that tend to concentrate contaminants to a higher degree than other species due to high mobility. For this reason it was recommended by FAO/UNEP [4] as monitoring species. The concentrations of heavy metals found in *M. barbatus* varied, with Hg ranging from 14-520, Cd from 0.10-10, Pb from 2.6-478, Cr from 22-270, Cu from 178-568 and Zn from 2157-3832 mg kg^{-1} wet weight in the bay. The order of heavy metal concentrations were: Zn>Cu>Pb>Cr>Hg>Cd. The comparison of metal concentrations demonstrate that, there are no significant ($p<0.05$) regional variations during 1996-2009 except mercury ($df=5$, $F=4.974$, $p=0.0005$).

Conclusions
Most of the heavy metals concentrations in sediments were generally similar to the background levels from the Mediterranean and Aegean Sea, except delta of Gediz River in the outer bay. The high concentration of heavy metals is observed in the inner part of the bay. The levels of metals are lower in the inner bay than polluted areas of Mediterranean. Hg and Cd concentrations are higher than the reported mean values of heavy metals in fish organisms from the Aegean Sea and Mediterranean. Lead concentrations are similar to those reported in fish from Mediterranean countries.

References
1 - UNEP., 1984. Determination of total Cd, Zn, Pb and Cu in selected marine organisms by flameless AAS. Reference Methods for Marine Pollution Studies 11.
2 - UNEP., 1985a,b,c,d. Determination of total Hg, Cd,Cr, Pb in marine sediments and suspended solids by cold vapour AAS. Reference Methods for Marine Pollution Studies 26,27,31,34.
3 - UNEP., 1985. Cadmium, lead and tin in the marine environment. UNEP Regional Seas Reports and Studies 56.
4 - FAO/UNEP., 1993. Report of the FAO/UNEP/IAEA training workshop on the design of monitoring programmes and management of data concerning chemical contaminants in marine organisms, Athens, 247pp.

MEDITERRANEAN SEA PRIMARY PRODUCTIVITY SIMULATED BY OPATM-BFM MODEL

P. Lazzari [1]*, V. Ibello [1], A. Teruzzi [1], S. Colella [2], S. Salon [1], C. Solidoro [1] and A. Crise [1]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS - plazzari@ogs.trieste.it
[2] ISAC CNR, Roma, Italy

Abstract

We present an analysis of the primary productivity estimation for the Mediterranean Sea carried out by the numerical tool OPATM-BFM. Annual budget of primary productivity is quantified and compared with other estimations based on satellite observations and in-situ measurements. Model results are discussed and summarized considering the main biogeochemical properties and their inter-annual variability (period 1999-2004) at the sub-basins level with a particular interest to primary productivity (PP).

Keywords: Primary Production, Models, Pelagic

Introduction

Scenarios analyses indicate that the anthropogenic pressure on the Mediterranean Sea environment will significantly increase in the next decades. Optimal management of this rapid change requires a quantitative knowledge of the Mediterranean Sea functioning based on an integrated view that may include in-situ remote measurements and modelling projections. Models represent the only system able to quantitatively estimate with high space/time resolution the biogeochemical processes at basin scale. We applied a model developed in the framework of the operational short-term forecast [1] for a multi-annual simulation of plankton productivity.

Model

OPATM-BFM is a three-dimensional transport-reaction model developed to simulate the evolution of the marine biogeochemistry. It is designed to resolve the seasonal cycle of primary producers on the Mediterranean basin spatial scale. The model in its current version has an horizontal resolution of 0.125 degrees with 43 vertical levels. The system is forced with physical parameters produced by an external high- resolution Ocean General Circulation Model (OGCM) according to the off-line approach. Advection, diffusion and sinking are implemented by a modified version of OPATM code, OPA Tracer Model version v8.1 [2]. The reaction term is implemented by the BFM model version 2.0 [3]. The physical parameters are computed by the MED16 OGCM forced by the atmospheric fields of the ECMWF reanalysis for the period 1998-2004. Photosynthetic Available Radiance (PAR) is modulated by a satellite-estimated extinction parameter. Initial and boundary conditions (for the Gibraltar Strait input) are obtained from the nutrient climatological dataset MEDAR MEDATLAS 2002.

Result and Discussion

Table 1 shows the annual averages (as arithmetic means) of PP estimated by OPATM-BFM model, SeaWiFS, and by data synthesis of in situ measurements for different sub basins of the Mediterranean Sea, Fig. 1. Overall there is a good correspondence among different estimations for all the sub-basins, with an average productivity around 94 mgC m^{-2} y^{-1} for the whole Mediterranean Sea basin. The western Mediterranean is characterized by an higher average productivity level, around 127 mgC m^{-2} y^{-1}, including Alboran Sea, while the eastern Mediterranean average productivity is lower and around 72 mgC m^{-2} y^{-1}. A seasonal cycle is evident for each year considered in the present simulations, both in the western and eastern sub-basins. The maxima of primary production occur always during the winter period while the minima occur in late autumn, as shown in the time series of the period 1999-2004, Fig. 1. In the ALB sub-basin, the seasonal cycle is super-imposed to the high frequency peaks related to the highly dynamical regime of this area. The NWM area has a dominant seasonal cycle with an evident maximum of the productive peak in 2003 (around 1 gC m^{-2} d^{-1}). LEV area shows maxima of productivity in April and very low values during summer and autumn periods, even below 50 mgC m^{-2} d^{-1}. In summary, our model gives full spatial/temporal coverage for the period considered, providing an estimate of the biogeochemical properties not measured experimentally.

Tab. 1. Horizontal averages of vertical integrated primary productions (gC.m^{-2}.y^{-1}) for the period 1999-2004. On parenthesis (average of the annual variance, variance of the annual average). Western basin includes Alboran Sea, North and South Western Mediterranean, Thyrrenian Sea. Eastern basin includes Ionian and Levantine sub-basins. [5] Crispi et al., 2002; [6] Simone Colella Phd Thesis; In situ data: [7] Sournia et al., 1973; [8] Bethoux et al.,1989; [9] Conan et al.,1998, Moutin e Raimbault, 2002; [10] Dugdale and Wilkerson, 1988; [11] Boldrin et al., 2002; [12] Moutin and Raimbault, 2002.

NPP	OPATM-BFM	Other Model[5]	Satellite model[6]	In Situ
Mediterranean	94 (±84/±4)	*	90 (±50/±3)	80-90[7]
Western Med	127 (±103/±5)	120	112 (±67/±6)	120[8]/140-150[9]
Eastern Med	73 (±61/±4)	56	76 (±24/±3)	20[10]/62-97[11]/99[12]

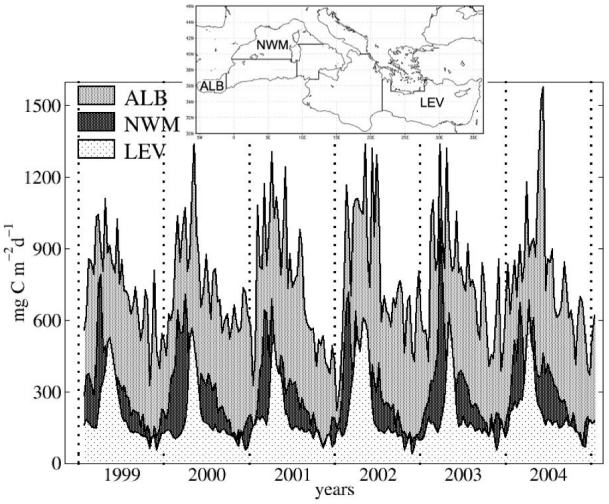


Fig. 1. Six years (1999-2004) time series of vertically integrated primary productivity horizontally averaged on three sub-basins: Alboran Sea (ALB), North Western Mediterranean (NWM), Levantine Basin (LEV). Sub-basin map is shown in top panel.

References

1 - Lazzari P., Teruzzi A., Salon S., Campagna S., Calonaci C., Colella S., Tonani M. and Crise A., 2010. Pre-operational short-term forecasts for the Mediterranean Sea biogeochemistry, Ocean Sci., in press.

2 - Madec G., Delecluse P., Imbard M. and Levy C., 1998. OPA 8.1 Ocean General Circulation Model Reference Manual, Note No. 11, Laboratoire d'Oceanographie Dynamique et de Climatologie, Institut Pierre Simon Laplace, Paris, France, 97 pp.

3 - Vichi M., Pinardi N. and Masina S., 2007. A generalized model of pelagic biogeochemistry for the global ocean ecosystem. Par t I: Theory, J. Marine Syst., 64, 89–109.

INFLUENCE OF *POSIDONIA OCEANICA* ON THE DISTRIBUTION OF NATURAL AND ANTHROPOGENIC RADIONUCLIDES IN COASTAL SEDIMENTS OF THE NORTHWEST MEDITERRANEAN SEA

S. H. Lee [1], P. P. Povinec [2]*, M. Betti [3], J. R. Chisholm [4], J. Gastaud [3], I. Levy [3] and J. C. Miquel [3]
[1] Korea Research Institute of Standards and Science, Daejeon, South Korea
[2] Comenius University, Faculty of Mathematics, Physics and Informatics, Bratislava, Slovakia - povinec@fmph.uniba.sk
[3] International Atomic Energy Agency, Marine Environment Laboratories, Monaco
[4] Scientific Centre of Monaco, Monaco

Abstract
Samples were collected adjacent to the Island of Porquerolles in the Northwest Mediterranean Sea to study the distribution of natural and anthropogenic radionuclides in heavily oxygen-depleted sediments associated with the decomposition of organic carbon derived from the sea grass *Posidonia oceanica*. Elevated isotopic concentrations of uranium (^{234}U and ^{238}U up to 200 Bq/kg d.w.) were likely due to the high organic carbon and very low oxygen content of the sediment.
Keywords: Western Mediterranean, Sediments, Radionuclides

Introduction
Coastal sediments are ultimate sinks for particulate matter in the water column and as such, represent important repositories of historical information on contaminant levels in the marine environment. The present study sought to obtain new information on the distribution of natural and anthropogenic radionuclides in coastal sediments and to investigate how their concentrations are regulated by diagenetic processes associated with the decomposition of organic carbon derived from *Posidonia oceanica*. In order to interpret the sedimentary processes and to study contamination over the last century, a dating method derived from the excess of ^{210}Pb was used together with ^{137}Cs horizon produced by global fallout and from the Chernobyl accident [1,2].

Samples and methods
Sediment samples were collected in 2002 near the Island of Porquerolles in the Northwest (NW) Mediterranean Sea by the Scientific Centre of Monaco [3]. Weapons tests conducted by the French navy had formerly disturbed both sea grass cover (*Posidonia oceanica*) and sediments in the study area, resulting in extensive growth of the green alga *Caulerpa taxifolia* [3]. Two sediment cores (100 mm in diameter and 0.8 long) were collected by divers at a region of overlap between two weapons-damaged areas (St. 1 and 2). A third core was collected by divers at a control site 6 km away from the damaged area (St. 3). A more distant reference core (St. 4) was collected offshore near Monaco. The St. 1 core was stored in a refrigerator and exposed to a sensitive photographic film for one week. The cores were freeze-dried and sliced transversely into 10 mm thick sections, and pulverized using an agate mortar and pestle prior to radiochemical analysis. Samples were analysed for anthropogenic (^{137}Cs, ^{238}Pu, ^{239,240}Pu and ^{241}Am) and natural (^{226}Ra, ^{210}Pb, ^{210}Po, ^{234}U, ^{235}U and ^{238}U) radionuclides and for organic carbon (OC). ^{210}Pb(excess) was derived from the measured ^{210}Pb (total) and ^{226}Ra profiles, in order to date the cores by reference to their sediment accumulation rates.

Results and discussion
The sediment cores obtained at St. 1, St. 2 and St. 3 all bore the hallmarks of anoxia: dark-grey colour, strong H_2S smell and the organic remains of *Posidonia oceanica* dispersed throughout. OC is oxidized by O_2 and via the reduction of NO_3^-, SO_4^{2-} and Mn/Fe oxides in sediments. The contribution of reduced species to O_2 consumption is effectively enhanced in coastal areas where anoxic conditions can be established even in surficial sediments due to high inputs of organic matter [4]. The sediments found at Porquerolles were highly anoxic, as evidenced by a lack of Mn peaks in the surface layers, whereas St. 4 showed a high concentration of Mn in the surface layer caused by the formation of MnO_2 (Mn analyses carried out by XRF). Organic carbon plays a critical role in determining the distribution of major elements and radionuclides in coastal sediments via its influence on diagenesis [5,6]. The surface OC content of Porquerolles sediments was much higher than previously reported (3.4 to 5.7 % versus < 1% in the western Gulf of Lions [4]) and could be attributed to the substantially greater density of vegetation cover. Fragments of *Posidonia oceanica* were found throughout the Porquerolles' sediment profiles following weapons tests that killed the sea grass beds and caused the rapid formation of new layer of organically rich sediment [3]. The OC content of the distant reference core taken at St. 4 was much lower (0.6 to 1.1 %) and was comparable with values determined in previous investigations [4]. The ^{210}Pb$_{(ex.)}$ profiles of Porquerolles sediments revealed the impacts of weapon tests, which produced mixed sediment layers and high sediment accumulation rates up to 1.2 cm yr^{-1}, higher than have been reported elsewhere in NW Mediterranean [1,7]. The photographic film placed on the sediment core collected at St. 1 displayed evidence of exposure to radiation emitted from the sediment surface. A few "hot" particles were isolated from the sediment at depths close to 40 cm from the surface, and analysed by SIMS. These analyses confirmed the presence of highly enriched U particles (AMS analyses of "hot" particles are still in progress). The origin of "hot" particles in the sediment is not yet known. Radiometric analyses of bulk sediment samples revealed U isotope concentrations at Stations 1 and 2 (^{234}U and ^{238}U up to 200 Bk/kg d.w.) well in excess of those measured at Stations 3 and 4. The peak U concentrations were observed at depths of around 40 cm, which coincided with a peak in OC concentration. High oxidation state of uranium (VI) dissolved in pore water tends to be reduced to immobile U(IV) and precipitate beneath the redoxcline. When the degradable organic matter in sediment is completely consumed, no further incorporation of U occurs in the sediment, and authigenic U is recycled to the ocean [6]. The high OC load and strong reducing conditions in the sediment at Porquerolles likely explains the high total U content. The average activity ratio of ^{234}U/^{238}U is 1.107 ± 0.018, consistent with the world's ocean value of 1.12 ± 0.01 [8]. The average activity ratio of ^{235}U/^{238}U is 0.038 ± 0.006, which is close to the natural level (0.047), but different from values characterising either an enriched U (0.091), or a depleted U (0.019). ^{239,240}Pu and ^{241}Am levels in surface sediments ranged from 1.0 to 5.7 Bq/kg and from 0.3 to 1.0 Bq/kg d.w., respectively. ^{137}Cs levels were between 0.3 and 6.2 Bq/kg. We may conclude: While high uranium content observed at St. 1 may be due to the high organic carbon and very low oxygen content of the sediment, the origin of uranium enriched particles in the sediment is not yet known, and further investigations are on the way to explain this anomaly.

References
1 - Zuo, Z., Eisma, D., Gieles, R., Beks, J., 1997. Accumulation rates and sediment deposition in the northwestern Mediterranean. *Deep Sea Research* II, 44: 597-609.
2 - Masqué, P., Fabres, J., Canals, M., Sanchez-Cabeza, J. A., Sanchez-Vidal, A., Cacho, I., Calafat, A. M., Bruach, J. M., 2003. Accumulation rates of major constituents of hemipelagic sediments in the deep Alboran Sea: a centennial perspective of sedimentary dynamics. *Marine Geology*, 193: 207-233.
3 - Chisholm, J.R.M., Povinec, P.P., Briet, V., Gastaud, J., Jaubert, J.M., Lee, S-H., Levy-Palomo, I., Marchioretti, M., Minghelli-Roman, A., 2007. A century of warfare shoots holes in anti-*Caulerpa* campaign. *Nature Precedings*, doi:10.1038/npre.2007.1240.1.
4 - Accornero, A., Picon P., De Bovée, F., Charrière, B., Buscail, R., 2003. Organic carbon budget at the sediment-water interface on the Gulf of Lions continental margin. *Continental Shelf Research*, 23: 79-92.
5 - Ogrinc, N; Fontolan, G; Faganeli, J; Covelli, S., 2005. Carbon and nitrogen isotope compositions of organic matter in coastal marine sediments (the Gulf of Trieste, N Adriatic Sea): indicators of sources and preservation. *Marine Chemistry*, 95: 163-181.
6 - Mangini, M., Jung, M., Laukenmann, S., 2001. What do we learn from peaks of uranium and of manganese in deep sea sediments? *Marine Geology*, 177: 63-78.
7 - Sanchez-Cabeza, J.A., Masque, P., Ani-Ragolta, I., Merino, J., Frignani, M., Alvisi, F., Palanques, A., Puig, P., 1999. Sediment accumulation rates in the southern Barcelona continental margin (NW Mediterranean Sea) derived from ^{210}Pb and ^{137}Cs chronology. *Progress in Oceanography*, 44: 313-332.
8 - Lee, S.-H., La Rosa, J., Levy-Palomo, I., Oregioni, B., Pham, M., Povinec, P., Wyse, E., 2003. Recent inputs and budgets of ^{90}Sr, ^{137}Cs, ^{239,240} Pu and ^{241}Am in the northwest Mediterranean Sea. *Deep-Sea Research* II, 50: 2817-2834.

INCREASINGLY DIFFICULT RESPIRATION OF AEROBIC ORGANISMS IN THE MESOPELAGIC LAYER: POSSIBLE ADAPTATION STRATEGY

Louis Legendre [1]*
[1] Laboratoire d'Océanographie de Villefranche - legendre@obs-vlfr.fr

Abstract

The provision of intermediate waters that are hospitable for aerobic life is a major service supplied by the sea, but respiration is becoming increasingly difficult for mesopelagic aerobic organisms: oxygen is decreasing in minimum oxygen zones in many regions, and increasing carbon dioxide contributes to lower the free energy from respiration. Reduction of this service calls for adaptation because the increasingly difficult mesopelagic respiration will be accompanied by a reduction of biodiversity that may progress so rapidly that many taxa may disappear before we know they exist. With them would disappear their potential services. The only possible adaptation strategy may be to accelerate the study of diversity in intermediate waters, which is more vulnerable to climate change than diversity in surface or deep waters.

Keywords: Oxygen, Biodiversity, Intermediate Waters, Global Change

INTRODUCTION

The long-term provision of intermediate waters (from 100 to 1000 m) that are generally hospitable for aerobic life is a major service that is presently supplied by the sea. However, respiration is becoming increasingly difficult for aerobic organisms in the mesopelagic layer (also called twilight zone) for two reasons.

METHODS AND STUDY SITES

Firstly, concentrations of dissolved oxygen are decreasing in minimum oxygen zones (OMZs, generally between 300 and 700 m) in many regions [3, 4], and are predicted to continue to decrease in coming decades and centuries [2]. The presently existing major OMZs with very low oxygen concentrations are located in the Eastern South Pacific Ocean, Eastern Tropical North Pacific Ocean, Arabian Sea and Bay of Bengal. A reduction of oxygen by 20-40% is predicted in deeper oceanic waters over the coming 700 years, but this should not lead to extensive deep-ocean anoxia [2]. Hence, climate change threatens dissolved oxygen more in intermediate waters than in surface or deep waters.

Secondly, the concentration of total carbon dioxide is progressively increasing in surface and intermediate waters. The energy from respiration that can be converted into work by organisms (called free energy) is related directly to dissolved oxygen and inversely to dissolved carbon dioxide [1]. Hence, the combination of decreasing oxygen and increasing carbon dioxide is presently reducing and will continue to reduce the free energy of respiration. This will make respiration of aerobic organisms in intermediate waters increasingly difficult.

RESULTS AND DISCUSSION

The combination of the above two processes will reduce a service that the sea had been providing to aerobic life for millennia. This serious environmental problem should be an additional incentive for governments to address the mitigation of global change internationally and without delay. However, even if mitigation policies were implemented efficiently and rapidly, the respiration of mesopelagic aerobic organisms would nevertheless become increasingly difficult in many areas. These respiration problems will lead to a reduction in the biodiversity of mesopelagic pelagic aerobic organisms. Hence, reduction of the above service calls for an adaptation strategy as discussed in the next paragraph.

On the one hand, diversity of the biota in intermediate waters is still largely unknown, and represents a nearly untapped reservoir of future services to humans. On the other hand, respiration problems may progress so rapidly in intermediate waters that many groups of organism there may disappear before we even know they exist, and with them would disappear their potential services. Hence, the only possible adaptation strategy available to human societies may be to accelerate the study of biodiversity in intermediate waters. The previous discussion has shown that mesopelagic biodiversity is more vulnerable to the strain exerted on aerobic respiration by climate change than biodiversity in surface or deep waters.

The above conclusion should reinforce the resolve of the international oceanographic community to target intermediate waters for priority studies in the coming years and decades (e.g. the international programme "Integrated Marine Biogeochemistry and Ecosystem Research", IMBER). Mediterranean researchers should take part in this international effort.

References

1 - Brewer, P.G. and E. T. Peltzer, 2009. Limits to marine life. *Science*, 324: 347-348.

2 - Matear, R. J. and A. C. Hirst, 2003. Long-term changes in dissolved oxygen concentrations in the ocean caused by protracted global warming. *Global Biogeochem. Cycles*, 17: 1125, doi:10.1029/2002GB001997.

3 - Paulmier, A. and D. Ruiz-Pino, 2009. Oxygen minimum zones (OMZs) in the modern ocean. *Progr. Oceanogr.*, 80: 113-128.

4 - Stramma, L, Johnson, G. C., Sprintall, J. and V. Mohrholz, 2008. Expanding oxygen-minimum zones in the tropical oceans. *Science*, 320: 655-658.

HEAVY METAL CONCENTRATIONS IN THE MEDITERRANEAN MUSSELS (*MYTILUS GALLOPROVINCIALIS*) COLLECTED FROM THE DARDANELLES

A. Lök [1]*, S. Çolakoglu [2], S. Acarli [1], S. Serdar [1], A. Küçükdermenci [1], S. Yigitkurt [1], A. Kirtik [1] and M. Güler [1]
[1] Ege University, Fisheries Faculty, 35100, Izmir-Turkey - aynur.lok@ege.edu.tr
[2] Ministry of Agriculture and Rural Affairs, Çanakkale-Turkey

Abstract
Concentrations of eight heavy metal (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn) were determined in mussels (*M. galloprovincialis*) collected in September, 2006 from 5 locations in Dardanelles, Turkey. All measurements were carried out in Atomic absorption Spectrofotometer(AAS). The heavy metal levels determined for mussel were found to be 0.032-0.048 µg As/g, 0.101-0.520 µg Cd/g); 0.141-0.78 µg Cr /g, 0.542-0.661 µg Cu /g, 0.005-0.034 µg Hg /g, 0.081-0.383 µg Ni /g, 0.220-18.474 µg Pb /g and 32.549-65.612 µg Zn /g wet weight.
Keywords: Trace Elements, Bivalves, Dardanelles

Introduction
Heavy metal discharges to the marine environment are of great concern all over the world. Both essential (e.g., Fe, Zn, Cu) and non essential (e.g., Hg, Cd, Pb) metals are toxic to living organisms when subjected to high concentrations [1, 2]. Mussels of the genus *Mytilus* and related genera are useful as bioindicators because they have wide distribution on all continents from tropical to high latitudes. They are filter feeders extracting metals from water and particulate matter, and they store some metals at levels high above those in the abiotic environment [3]. *M. galloprovincialis* is wide-spread on the Dardanelles coasts and they collected from wild for human consumption in Turkey. The selected locations in the Dardanelles are especially suitable for its growth which makes it a good choice for a biomonitor of the researched area. The aim of this study was to use *M. galloprovincialis* as the biomonitor of the marine environment and bioindicator of the possible contamination.

Materials and Methods
The study was carried out in Dardanelles at five sampling sites (Kilye, Akbas, Suluca, Kepez, Karacaören) (Fig.1). Samplings were conducted from wild in September, 2006. About 25-30 mussels from each sampling site were selected and analysed for heavy metals. The soft tissue of samples was digested in concentrated HNO_3 in a commercial microwave oven. Following acid digestion, all samples were analyzed for 8 elements by atomic absorption spectrophotometry (Perkin Elmer AA 700). Zn was determined in an air-acetylene flame. Cd, Cr, Cu, Ni and Lead were analysed in a graphite furnace. Cold-vapor for analysis of Hg and hydride generation techniques were used for analysis of As. The standard addition method was used to correct for matrix effects. All acids and reagents were analytical grade (Suprapur-Merck). The detection limits for heavy metals were: As, 0.002; Cd, 0.001; Cr, 0.002; Cu, 0.001; Hg, 0.005; Ni, 0.003; Pb, 0.001; Zn, 0.08 µg/g. Results were presented as arithmetic mean values (µg/g -wet weight).

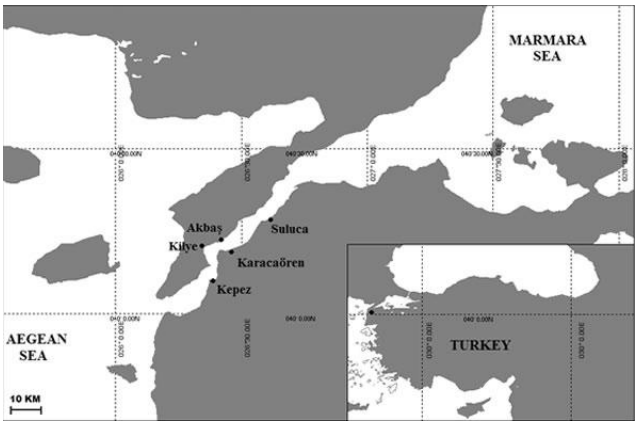


Fig. 1. Mussel sampling locations in Dardanelles

Results and Discussion
To facilitate the analysis the results samples with a length shell of 60-70mm size, which is the most commercial mussel length, were analyzed. Metal concentrations (means ± standard deviations) in the soft tissues *M. gallopovincialis* arepresented in Table 1. Hg concentrations were the lowest for all stations while Zinc was the highest mean concentrations.

Tab. 1. Metal levels (µg/g wet weight) in the tissue of *M. galloprovincialis* collected from 5 locations.

Metals (µg/g)	Locations in Dardanelles				
	Kilye	Akbaş	Suluca	Kepez	Karacaoren
As	0.038±0.0079	0.032±0.0057	0.048±0.0217	0.046±0.0312	0.044±0.0298
Cd	0.520±0.0400	0.457±0.0127	0.180±0.0178	0.101±0.0501	0.152±0.0453
Cr	0.160±0.0478	0.174±0.0502	0.174±0.0523	0.178±0.0554	0.141±0.0357
Cu	0.661±0.0421	0.621±0.0402	0.542±0.0252	0.626±0.0458	0.647±0.0423
Hg	0.034±0.0057	0.005±0.0002	0.015±0.0054	0.009±0.0055	0.007±0.0048
Ni	0.350±0.0362	0.298±0.0172	0.383±0.0388	0.346±0.0361	0.081±0.0188
Pb	13.574±1.233	18.474±2.765	0.448±0.0406	0.220±0.0245	0.230±0.0333
Zn	56.923±5.678	65.612±5.976	41.420±3.347	32.549±2.997	41.739±3.466

Mussels and bivalves in general are known to be efficient accumulators of certain metals, particularly zinc, which can be stored against a concentration gradient of orders of magnitude. Other metals, particularly lead and mercury, are not bioconcentrated efficiently by bivalves [4]. In this study we observed similar results for the Zinc concentrations as the highest value in the mussel soft tissues collected from all sampling locations. By using *M. galloprovincialis* as a biomonitoring agent, the contamination of As, Cd, Cr, Cu, Hg, Ni in the Dardanelles was not found to be serious. However Zn and Pb levels in the samples collected from Kilye and Akbas were above the legal limits set by national Standards of Turkish Governments. Future studies should concentrate on the relative importance of water, sediment and food in the accumulation of metals by the mussels. From the human public health point of view, these results seem to show no possibility of acute toxicities of As, Cd, Cr, Cu, Hg and Ni if the edible mussels are consumed.

References
1 - Underwood E. and Mertz W., 1987. Introduction. *In*: Mertz W. (ed). Trace elements in human and animal Nutrition. *Academic Press, New York*, vol. 1, pp 1-19.
2 - Andersen V., Maage A. and Johannessen P.J., 1996. Heavy metals in blue mussels (*Mytilus edulis*) in the Bergen Harbor area, Western Norway. *Bull. Environ. Contam. Toxicol*., 57:589-596.
3 - Perez U.J., Jimenez B., Delgado W. and Rodriguez-Sierra C.J., 2001. Heavy metals in the false mussel, *Mytilopsis domingensis*, from two tropical estuarine lagoons. *Bull. Environ. Contam. Toxicol*., 66: 206–13.
4 - Zachariadis G.A., Anthemidis A.N. Caniou I. and Stratis J.A., 2001. Determination of lead, cadmium and mercury in surface marine sediments and mussels. *J. Environ. Anal. Chem*. 80:153–60.

SEASONAL VARIATIONS OF DIOXIN-LIKE ACTIVITY IN SEDIMENTS OF THE BIZERTA LAGOON (TUNISIA) DETECTED WITH IN VITRO CELLULAR BIOASSAYS

I. Louiz [1]*, O. Ben-Hassine [1], M. Ben-Attia [2], S. Kinani [3] and S. Aït-Aïssa [4]

[1] Unité de recherche de Biologie, Écologie et Parasitologie des Organismes Aquatiques, Faculté des sciences de Tunis, 2092, Tunisie - louizibtissem@yahoo.fr

[2] Laboratoire Chimie et Mécanismes Réactionnels, Ecole Polytechnique, Palaiseau, France

[3] Unité d'Ecotoxicologie, INERIS, Verneuil-en-Halatte, France

[4] Laboratoire de Biosurveillance de l'Environnement, Faculté des Sciences de Bizerte, Zarzouna, Tunisie

Abstract

In order to evaluate sediment contamination in six stations from Bizerta lagoon, a combination of *in vitro* bioassays and chemical analysis was applied to sediment organic extracts. By using 7- ethoxyresorufin-O-deethylase (EROD) induction in the fish hepatoma cell line PLHC-1 after 4 h of cell exposure, dioxin-like activities were detected in all analysed samples. Dioxin-like activities were higher in winter than in summer. A highly significant correlation was observed between bioassay- and chemical analyses-derived toxic equivalents (TEQs), but PAHs accounted for only a small part of the detected biological activities. Our results suggest the presence of unknown readily metabolised EROD inducing compounds, which will need to be further characterized.

Keywords: Lagoons, Pollution, Sediments, Ecotoxicology

Introduction

Bizerta lagoon, situated in northern Tunisia, is an important ecological area implicated in various activities as fishing and aquaculture development. Unfortunately, this lagoon is submitted to many anthropic pressures, which led to chemical contaminations by various toxic compounds that may be biologically active. The aim of this study was (i) to evaluate the seasonal variations of dioxin-like chemicals, using in vitro bioassays, (ii) to compare bioassay data with PAHs analyses by using a toxic-equivalents (TEQ) approach.

Material and Methods

Superficial sediments were collected in January and July 2006 at six stations in Bizerta lagoon and at a reference station (GH) in the seawards entrance of Ghar el Melh lagoon. The sediment extracts were subjected to chemical and bioassays analyses. Then, the PAHs in sediment extract were quantified by gas chromatographic analysis. The EROD activity assay in PLHC-1 cells line was processed, as previously described by (1).

Dose–response curves were fitted by Hill equation model and the EC50 were calculated. Bioassay-derived benzo[a]pyrene- (BaP-EQ) and instrumentally derived toxic equivalents (TEQs) for PAHs were determined as described by (1).

Results and Discussion

As shown in Figure 1, all sediment extracts were able to induce EROD activity. The extract from Menzel Bourguiba (MB) site, which is subjected to intensive industrial activity, was the most active sample.

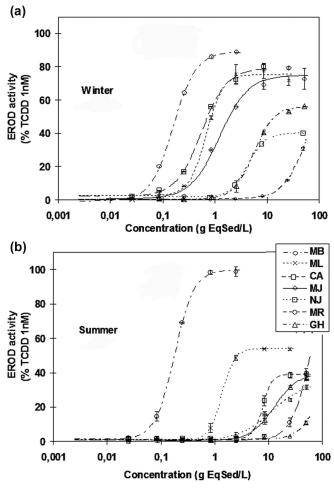


Fig. 1. EROD induction in PLHC-1 cells exposed for 4 h to serial dilution of sediment extracts sampled in winter (a) and summer (b). Results are expressed as percentage of maximal EROD activity induced by TCDD 1 nM. Values are means of triplicates ± SD.

Regarding seasonal variations, it is noteworthy that, although similar site ranking was observed between summer and winter, higher activities were observed in winter in all stations, except for MB site, which was still highly potent in summer. This result suggests that the chemicals responsible for activation are metabolized in hot season, and support the hypothesis for a major role of PAH-like chemicals in EROD induction.

The regression analyses (Figure 2) showed highly significant positive correlation between biological- and instrumental-derived TEQs (R2 = 0.94). However, when comparing toxic-equivalent values the TEQ-chem values explained only a small part of the biological activities detected by the bioassay, suggesting that other EROD-inducing compounds than the 16 analysed PAHs are present in the extracts.

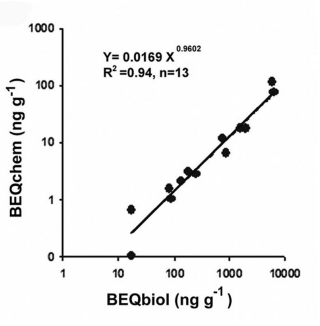


Fig. 2. Correlation between chemical analyses- and bioassays-derived BEQs determined in sediments extracts.

Conclusion

Seasonal variations were observed by both in vitro dioxin-like activities and PAHs concentrations in sediment extracts, which were lower in summer. Such variations probably reflect a higher abiotic and biological degradation of organic chemicals in the hot season. Furthermore, the dioxin-like responses observed in our study were thus likely to have been caused by other ubiquitous biogenic and anthropogenic PAH-like AhR ligands that were not taken into account by the chemical analyses.

References

1 - Louiz I., Kinani S., Gouze M.-E., Ben-Attia M., Menif D., Bouchonnet S., Porcher J.M., Ben-Hassine O.K., Aït-Aïssa S., 2008. Monitoring of dioxin-like, estrogenic and anti-androgenic activities in sediments of the Bizerta lagoon (Tunisia) by means of in vitro cell-based bioassays: Contribution of low concentrations of polynuclear aromatic hydrocarbons (PAHs). *Sci. Total Environ.* 402 (2-3): 318-329.

COMBINING A RTM BIOGEOCHEMICAL MODEL AND HIGH-FREQUENCY IN SITU OBSERVATIONS FOR THE SHORT-TERM PREDICTION OF ALGAL BLOOMS

T. Lovato [1]*, S. Ciavatta [2], D. Brigolin [1], A. Rubino [3] and R. Pastres [1]
[1] University Of Venice Ca' Foscari, Departement Of Physical Chemistry, Venice, I-30123. - lovato@unive.it
[2] Plymouth Marine Laboratory, Plymouth PL1 3DH, United Kingdom.
[3] University of Venice Ca' Foscari, Departement Of Environmental Sciences, Venice, I-30123.

Abstract
In the present study we propose a methodological approach for the early detection of macroalgae blooms in the lagoon of Venice. The approach basis on merging the pieces of information brought by a quasi real-time monitoring network and by a Reaction-Transport model of the lagoon. A case study is presented, where the relevant macroalgae standing crop observed in spring 2005 was satisfactorily estimated by constraining the model with continuous Dissolved Oxygen data collected at 7 lagoon sites. The results highlighted that the method is a valuable tool for the quasi real-time tracking of the primary productivity in the lagoon. That makes the approach a valuable tool for the early detection of threats to the ecosystem, such as the risk of anoxic crisis induced by macroalgae proliferation in coastal areas.
Keywords: Lagoons, Models, Monitoring, Blooms, Coastal Management

Introduction
Worldwide coastal areas are subjected to a composite ensemble of human pressures and evidences indicate that these ecosystems have increasingly become more stressed and dysfunctional [1,2]. In the last decades, monitoring, regulatory and management efforts have been carried out with the objective of improving the capability of these environments to recover their natural productivity and, thus, to contribute to the human welfare. The Lagoon of Venice is a valuable example of the complexity of the interaction between hydrodynamics, biogeochemical processes, and human actions aimed at counteracting the eutrophication processes [3,4]. Indeed, in the latest years, macroalgae standing crop have increased again in some lagoon areas were massive proliferations and critical anoxic conditions were observed in the eighties, despite anthropogenic loads of ammonia and reactive phosphorous have decreased. This sudden change in the decreasing trend of macroalgae population was promptly detected by the observing system set up by the Venice Water Authority [5]. The system integrates quasi real-time observations of hydrological parameters and periodical field surveys of trophic parameters. The aim of the present study is to propose a methodological approach useful for the early detection of macroalgae blooms in coastal areas. This approach integrates the continuous observations of parameter sensitive to primary production – in particular Dissolved Oxygen concentration (DO) - with a Reaction-Transport Model (RTM) of the ecosystem. A case study is presented, were the approach has been applied to the estimation of the relevant macroalgae standing crop observed in the some areas of the Venice lagoon in spring 2005.

Materials and methods
The RTM model of the Venice lagoon couples four modules: (i) a 2D transport module; (ii) a water temperature module, (iii) a pelagic biogeochemical module, and (iv) a benthic biogeochemical module, which describes the macroalgae dynamics. The Reaction-Transport equation is solved by means of an operator-splitting technique [6], i.e. the model solves the advective-diffusive processes at each time-step, while the reaction term is integrated using a larger time step. The model input data are current velocity fields, watershed loads of Nitrogen and Phosphorous, meteorological forcings, and the fluxes at the lagoon/sea boundary. The RTM model was applied to the estimation of macroalgae standing crop in spring 2005. To this aim, the model was firstly calibrated by exploiting monthly data collected in the lagoon in 2004 by the Venice Water Authority. The model was then applied to quantify the macroalgae standing crop in spring 2005 by using an "inverse" procedure. In this procedure, the model was iteratively run by varying the winter initial macroalgae biomass up to the value that lead a good fitting of the continuous DO observations in the spring months.

Results and Discussion
The model calibration for the year 2004, lead to a good representation of the observed fields of monthly nutrient and dissolved oxygen concentrations. The iterative model runs for spring 2005 lead finally to track satisfactorily the continuous dissolved oxygen data collected by the quasi real-time observing system, as one can see in Fig. 1. The figure shows that the maximum daily values of the dissolved oxygen observations rise to 180 % passing from April to May, providing an evidence of a rapid increase in the primary production. The model reproduced quite promptly the increase in the daily ranges of the dissolved oxygen observations. The estimated values of macroalgae biomass leading to such a DO dynamic were in agreement with the results of field surveys carried out in spring 2005.

Conclusion
The case study demonstrated the usefulness of integrating the information brought by observing systems and Reaction-Transport models. Quasi-real time data can provide preliminary signals of macroalgae blooms, while their standing crop and biomass can be estimated by using the RTM model, opportunely calibrated by using the field observations. This integrated approach allowed us to investigate short and medium-term changes in macroalgae population in the lagoon of Venice. That suggests that the approach can support the efforts of early detection of threats to the ecosystem, such as the risk of anoxic crisis induced by macroalgae proliferation in coastal areas.

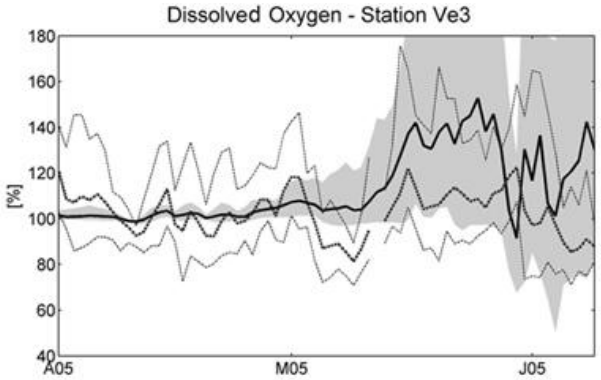


Fig. 1. Mean values and ranges of the i) field observations (dotted lines) and ii) model hindcast (continuous line and shaded area) of the Dissolved Oxygen concentrations in April-June 2005 at the Ve3 monitoring station.

References
1 - Rapport D.J., Costanza R., and McMichael A.J., 1998. Assessing ecosystem health. *Trends in Ecology and Evolution*, 13: 397-402.
2 - Lotze H.K., Lenihan H.S., Bourque B.J., Bradbury R.H., Cooke R.G., Kay M.C., Kidwell S.M., Kirby M.X., Peterson C.H., Jackson J.B.C., 2006. Depletion, Degradation, and Recovery Potential of Estuaries and Coastal Seas. *Science*, 312: 1806-1809.
3 - Pastres R., Ciavatta S., Cossarini G., Solidoro C., 2005. The seasonal distribution of dissolved inorganic nitrogen and phosphorous in the lagoon of Venice: A numerical analysis. *Environmental International*, 31: 1031-1039.
4 - Solidoro C., Pastres R., Cossarini G., 2005. Nitrogen and plankton dynamics in the lagoon of Venice. *Ecological Modelling*, 184: 103-124.
5 - Ferrari G., Badetti C., Ciavatta S., 2004. The real-time water quality monitoring network of the Venice Lagoon. *Sea Technology*, 45: 22-26.
6 - Press W.H., Flannery B.P., Teukolsky S.A., Vetterling W.T., 1987. Numerical Recipes, the Art of Scientific Computing. Cambridge University Press, Cambridge.

DISTRIBUTIONS OF $PH_{T,}$ TOTAL ALKALINITY AND CO_2 FUGACITY IN THE ADRIATIC SEA DURING THE SESAME CAMPAIGNS, WINTER AND LATE SUMMER 2008.

Anna Luchetta [1]*, Giulio Catalano [1], Carolina Cantoni [1] and Stefano Cozzi [1]
[1] CNR ISMAR sede di Trieste - anna.luchetta@ts.ismar.cnr.it

Abstract
pH_T experimental data of good quality are still scarce in the Mediterranean as in theAdriatic Sea. Here are presented the results of two repeated surveys at basin scale, conducted within SESAME project, showing significant longitudinal and seasonal variabilities of the pH_T and other carbonate system parameters.
Keywords: Adriatic Sea, Carbon, Global Change, Ph

The rapid response of the Mediterranean basin to the climate change [1] can be particularly true for the CO_2 induced acidification of seawater; as a consequence the Mediterranean area would already present significant pH drops [2] however there's still lack of good quality experimental data, witnessing such an occurrence [3], in particular in the Eastern Mediterranean Sea. The Adriatic Sea can play a very crucial role for the entire Eastern Mediterranean basin: as it issurrounded by industrialized regions, releasing carbon dioxide to the atmosphere, and during winter water mass can be so cold that CO_2 solubility pump mechanism can efficiently work increasing the dissolved CO_2 amount pushing toward acidified conditions. In addition the basin is site of dense water formation, either on the northern shallow shelf [North Adriatic Deep Water (NAdDW), and by the deep Southern Adriatic Pit, Adriatic Deep Water (ADW). Adriatic dense waters after formation usually sink and outflow through the Otranto Strait sill (750 m), which controls the export to Ionian and Eastern Mediterranean Seas [4]. In this way Adriatic dense water masses have the possibility of sequestering acidified waters and spreading around through the Eastern Mediterranean impacting on biogeochemical cycles and ecosystems. We present and discuss two datasets ($pH_{T,}$ TA and other carbonate systemparameters) gathered during the surveys conducted in the frame of the SESAME EU project and providing two seasonal snapshots (February and October 2008). **Methods** pH has been measured by the spectrophotometric method as described by Dickson [5], values are expressed on the total H^+ scale ($pH_{T,}$ in µmol H^+/kg_{SW}), at 25 °C, with a precision of ± 0.001 pH units. To our knowledge the dataset is the first collected with such a precision. The total alkalinity was experimentally determined (potentiometric titration, precision ± 1.0 µm/kg_{sw}), as reported by Dickson, Certified Reference Material has been used. From the experimental determination, the in situ pH_T values and all the other parameters of the carbonate system (fCO_2, TCO_2, H_2CO_3, $CO_3^=$ and HCO_3^-, Revelle, calcium carbonate solubilities Ω_{Ar}, Ω_{Ca}) can be derived (by CO2SYS program [6] **Results and discussion** Our results indicate that in winter 2008 the North Adriatic shelf, being shallow and exposed to cold dry winds (Bora), was involved in a dense water formation event on meso scale. The water column was cold (8< T < 12 °C), well homogenized and dense (σ_t > 29.4 kg/m^3), T/S properties are in agreement with those of NAdDW. It appeared also well ventilated (Apparent Oxygen Utilization mean value ~ 0 µM), still rich of nutrients (1.00<DIN<7.00 µM; 1.20< SiO_2 <5.33 µM), while the values of pH_T and allthe other carbonate system parametersexhibited a very low variability within the water column (7.917 < pH_T <7.973 pH_T units; 290.0 <fCO_2<334.6 µatm, thus resulting much lower than the equilibrium value with atmospheric CO_2 =398 µatm, mean value on measurements conducted on board). In the remaining part of the section pHT and fCO_2 values showed larger variabilities (fCO_2 between 222.4 and 424.7 µatm; pH between 7.880 and 7.960) with the highest (fCO_2> 400 µatm) and lowest (pH_T <7.880 pH_T units) values both at the bottom of the Meso Adriatic Pit, corresponding to AOU (> 65.0 µM) and nutrients (SiO_2> 6.0 µM, DIN> 5.0 µM) maxima, thus suggesting the occurrence of an older water mass affected by remineralisation processes. Generally, NAdDW water mass flows southward and accumulates at the bottom of the Meso and Southern Adriatic pits (250 and 1250 m, respectively [4] as clearly indicated by density, higher than 29.3 and 29.2 respectively, at the bottom. For what concern the southern part of the section, in February 2008 a deep convection event was observed by the deepest stations, accompanied by deep mixing (σ_t around 29.15-29.16 kg/m^3 down to 600 m) with a mean pH_T value of 7.947 ± 0.003 pH_T units homogeneously distributed from surface almost to the bottom. Total Alkalinity values varied between 2769 and 2613 µMH^+/kg_{sw}, with a mean value of 2661 µMH^+/kg_{sw}. The highest TA values were found in the northern part of the basin, due to the influence of higly carbonatic rivers. At the beginning October '08 the situation appeared completely changed: vertical stratification of density, pH_T , TA and $fCO_{2,}$ was widespread over the whole Adriatic basin. Density, T, S, pH_T,TA and fCO_2 varied over a much wider range than in February, as expected in late summer season: 26.5 < σ_t < 29.45 kg/m^3, 13.0 < T < 21.0 °C, 37.250 < S < 38.800 psu, 7.850 < pH_T < 8.100 pH_T units; 2674<TA<2598 µMH^+/kg_{sw}; 319.2< fCO2 < 810.4 µatm, as the nutrients and AOU concentrations did (0.05<DIN<7.73 µM , 0.59<SiO2<10.48 µM). The northern shallow shelf region exhibited much warmer water (T>15.0°C, even at the bottom,) with higher pH_T values (7.960<pH_T<8.050 pH_T units), due to the influence of primary production, the highest fCO_2 values have been observed ($fCO2$ >450 µatm) there, such values were much higher than the equilibrium value (398 µatm) with atmospheric CO_2, thus indicating the whole northern basin was oversaturated with respect to atmospheric CO_2. Very low pH_T (<7.888 pH_Tunits) and very high <$fCO2$ values were still recognizable at the bottom of both the Meso Adriatic Pit. pH_T values within the upper euphotic layer were everywhere distinctly higher (>7.960 pH_T units) than in winter, as expected in warmer waters dominated by production processes. Again total alkalinity values (2674<TA<2598 µMH^+/kg_{sw}, mean value 2623 µMH^+/kg_{sw}) where higher in the northern part of the basin because of the discharging river loads. Concluding, the comparison between the two surveys at basin scale evidenced high spatial (longitudinal/latitudinal) and seasonal variabilities of the marine carbonate system parameters, largely exceeding the precision of the analytical methods. From a comparison of pH_T values in the cold NAdDW water mass between 1983 and 2008, an acidification of 0.063 pH_T units turns out [7]. Such findings confirm that the Adriatic Sea is sensitive to the climate change and to atmospheric gas solubilisation (as CO_2) and should merit consideration in a discussion on the impacts of OA on the biogeochemistry of the marine carbonate system.

References
1 - Milliman J.D., Jeftic L. and Sestini G.,1992. The Mediterranean Sea and Climate Change–An overview. In: Climatic Change and the Mediterranean. Jeftic L., Milliman J.D & G.Sestini (editors), 1992 Edward Arnold Publications. Kent.

2 - Yilmaz A. et al., 2008, Impacts of acidification on biological, chemical and physical systems in the Mediterranean and Black Seas. In: *CIESM Workshop Monographs* N° 36, F. Briand editor, CIESM, Monaco, 124 pp.

3 - MEDAR Group, 2002 MEDATLAS/2002 database. Mediterranean and Black Sea database of temperature salinity and bio-chemical parameters. Climatological Atlas. IFREMER Edition (4 Cd).

4 - Gacic M. et al. 2001. Adriatic Deep Water and Interaction with the Eastern Mediterranean Sea. In: Physical Ocenaography of the Adriatic Sea. Past, Present and Future. B. Cushman-Roisin, M. Gacic, M.P. Poulain and A, Artegiani, eds, Kluwer Academic Publishers, The Netherlands, (pp. 67-109).

5 - Dickson, A.G., Sabine, C.L. and Christian, J.R. (Eds.) 2007. Guide to best practices for ocean CO_2 measurements. PICES Special Publication 3, 191 pp.

6 - Lewis, E., and D. W. R. Wallace. 1998. Program Developed for CO2 System Calculations. ORNL/CDIAC-105. Carbon Dioxide Information Analysis Centre, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee.

7 - Luchetta A., Cantoni C. and Catalano G., 2009. New observations of CO_2 induced acidification in the Northern Adriatic sea, over the last quarter century. *Chemistry and Ecology*. accepted.

EXPORT PRODUCTION AND SEASONALITY OF COCCOLITHOPHORES AND DIATOMS IN THE PELAGIC IONIAN SEA

Elisa Malinverno [1]*, Paola Maffioli [1], Cesare Corselli [1] and Gert J. De Lange [2]
[1] Dept of Geological Sciences and Geotechnologies - Milano-Bicocca University - elisa.malinverno@unimib.it
[2] Geochemistry & Chemical Oceanography - Geosciences, University of Utrecht. The Netherlands

Abstract
In this work we present the results from a time series of sediment trap moorings located at 500 m in the pelagic Ionian Sea, focusing in particular on the biogenic calcareous and siliceous component. We quantify the fluxes of coccolithophores and diatoms, identifying a seasonal succession in the assemblage composition, as related to the environmental conditions.
Keywords: Coccolithophores, Diatoms, Particle Flux, Ionian Sea, Eastern Mediterranean

Introduction
The understanding of present-day biogenic fluxes is of key importance in providing information on how the ecological signal is transferred from the surface waters to the sediment archives, in order to interpret paleofluxes. In the oligotrophic eastern Mediterranean, coccolithophores are known to play a major role as primary producers, while diatoms are subordinate, also due to the significant silica-undersaturation of the basin. Therefore, while there are some previous data on the present-day fluxes of coccolithophores at several locations in the basin [1, 2, 3], there are only a few data on diatom fluxes [4,5] and no detailed information on their specific assemblage composition in the sinking fluxes. We investigated the fluxes of coccolithophores and diatoms along three yearly intervals of a 7-year-long sediment trap deployment above Urania basin (35°13'N, 21°30'E) in the Ionian Sea, aiming at assessing the seasonality and interannual variability of the sinking biogenic fluxes.

Methodology
Sediment traps are PPS5/2, with 1 m^2 aperture and 24 collection vials. Each mooring was deployed for approximately one year, resulting in a sample resolution of 10 to 15 days. Coccolithophores and diatoms were analyzed on sub-samples (1/800-1/8000 and 1/40 respectively) processed following standard methods [6,7 respectively] and expressed as number per square meter per day.

Results and Discussion
Preservation of both coccolithophores (coccoliths and coccospheres) and diatoms was very good at all samples. The presence of delicate species (holococcolithophores,
Discosphaera tubifera among coccolithophores and weakly silicified taxa among diatoms) indicates that no dissolution occurred during either sedimentation through the water column, or sample storage and processing. Overall, the assemblages recovered at our sediment-trap site are typical of subtropical areas of the world's oceans. In fact coccolithophore species are those typically found in assemblages from subtropical and temperate settings, dominated by the cosmopolitan *Emiliania huxleyi*. Diatoms are ~70% tropical-subtropical species, with a minor contribution from subtropical-temperate and temperate taxa and a very slight contribution from cold-water species. During the first year of observation (1999-2000), the total flux of coccolithophores and diatoms was maximum in late summer-fall, along with the total particle flux, decreased during the whole winter period and increased again in late spring. The combined fluxes of coccolithophores and diatoms allowed to identify three main periods within the annual cycle, characterized by different assemblage composition: a) late summer-fall period, characterized by highest coccolithophore species diversity, consisting of both surface oligotrophic and deep-dwelling taxa and warm water diatom taxa dominated by *Nitzschia interruptestriata* and *Thalassionema bacillare*; b) late fall-winter period, characterized by lower coccolithophore diversity, dominated by the cosmopolitan *E. huxleyi* and the deep-dwelling *Florisphaera profunda* and by the increase of cooler-water diatom taxa; c) spring period, characterized by highest relative abundance of *E. huxleyi* and decrease of *F. profunda* within coccolithophores and by an increase in abundance of major and minor diatom taxa. A similar seasonal pattern was identified in coccolithophore assemblage composition in the following years, although the pattern of total particle and coccolithophore flux was different. In fact maxima occurred either in late spring to summer (2000-2001) or in early spring to late spring (2005-2006). Nonetheless, the main changes in the relative abundance of the different coccolithophore species occurred in the same intervals. Diatom assemblages in these series are still under study. Overall, the variations identified in the coccolithophore and diatom fluxes in the investigated three-year time series testify the seasonal changes in surface water conditions, including the sea surface temperature cycle and the presence of stratification in the upper layers. The seasonal cycle of water column mixing and stratification results in fact in the development of a different production depth within the water column, with the increase of surface oligotrophic species from summer to fall, the prolonged persistence of a deep chlorophyll maximum from summer to late winter and a clear dominance of the most abundant r-selected species during periods of more extended water column mixing.

References
1 - Ziveri P., Rutten A., De Lange G., Thomson J. and Corselli C., 2000. Present-day coccolith fluxes recorded in central eastern Mediterranean sediment traps and surface sediments. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 158: 175-195.
2 - Triantaphyllou M.V., Ziveri P. and Tselepides A., 2004. Coccolithophore export production and response to seasonal surface water variability in the oligotrophic Cretan Sea (NE Mediterranean). *Micropaleontology*, 50 (suppl. 1): 127-144.
3 - Malinverno E., Triantaphyllou M.V., Stavrakakis S., Ziveri P. and Lykousis V., 2009. Seasonal and spatial variability of coccolithophore export production at the south-western margin of Crete (eastern Mediterranean). *Marine Micropaleontology*, 71: 131-147.
4 - De Lazzari, A., Boldrin, A., Rabitti, S., Turchetto, M.M., 1999. Variability and downward fluxes of particulate matter in the Otranto Strait area. *Journal of Marine Systems*, 20: 399-413
5 - Boldrin, A., Miserocchi, S., Rabitti, S., Turchetto, M.M., Balboni, V., Socal, G., 2002. Particulate matter in the southern Adriatic and Ionian Sea: characterisation and downward fluxes. *Journal of Marine Systems*, 33-34: (389-410).
6 - Bairbakhish, A.N., Bollman, J., Sprengel, C., Thierstein, H.R., 1999. Disintegration of aggregates and coccospheres in sediment trap samples. *Marine Micropaleontology*, 37 (2): 219-223.
7 - Simonsen, R., 1974. The diatom plankton of the Indian Ocean Expedition of R/V "Meteor" 1964 - 1965. *Reihe, D. "Meteor" Forscg. Ergebnisse*, 19: 1-107.

DISTRIBUTION DES RESIDUS DE POLYCHLOROBIPHENYLES DANS LE SEDIMENT SUPERFICIEL DU GOLFE DE TUNIS, MER MEDITERRANEE.

Wiem Masmoudi [1]*, Mohamed Salah Romdhane [2], Souhaila Kheriji [1] and Mhamed El Cafsi [3]

[1] UR Physiologie et d'Ecophysiologie des Organismes Aquatiques, Département des Sciences Biologiques, Faculté des Sciences de Tunis, Campus universitaire, 2092 Tunis, Tunisie

[2] Institut Supérieure de la Pêche et de l'Aquaculture de Bizerte, Rimel, BP 15, Bizerte 7080, Tunisie - maswiem@lycos.com

[3] UR Ecosystèmes et Ressources Aquatiques, Institut National Agronomique de Tunisie, 43 av. Charles Nicolle, 1082 Tunis, Tunisie

Abstract

L'analyse des résidus des polychlorobiphényles (PCBs) dans le sédiment côtier du golfe de Tunis nous a permis d'obtenir les premières données concernant la contamination de cette zone par ces composés organochlorés. Nos résultats ont révélé que les deux sites étudiés, Raoued et Radès, présentent des concentrations en PCBs non négligeables par rapport aux données de la littérature. L'hétérogénéité de la répartition des teneurs en PCBs est due essentiellement aux effets du courant qui a tendance à disperser les fines particules de sédiment vers le large d'où une accumulation plus importante des composés hydrophobes.

Keywords: Pcb, Pollution, Mediterranean Ridge

A cause de leurs propriétés hydrophobiques, les polluants organiques persistants (POPs) ont tendance à s'adsorber à la matière particulaire de l'environnement marin et à se déposer dans le sédiment. Ce dernier est une matrice idéale pour l'étude et le suivi des polluants dans l'environnement marin. Dans le présent travail nous nous sommes intéressés à étudier l'état de contamination du sédiment du golfe de Tunis par les PCBs. Deux sites cibles ont été choisis : plage de Raoued qui reçoit les rejets des stations d'épuration par le biais du canal Khélij, et plage de Radès à proximité de l'embouchure de l'oued Méliane qui reçoit des rejets industriels. Une campagne d'échantillonnage a été effectuée au printemps 2004 pour le prélèvement du sédiment dans la zone d'étude. Le sédiment superficiel a été échantillonné au niveau des stations étudiées à l'aide d'une benne « Van Veen ». L'analyse des résidus de PCBs a été réalisée selon la méthode AFNOR [1]. Les échantillons ont subit une extraction au Soxhlet et une série de purification au florisil et au mercure. Les extraits ainsi obtenus ont été analysés par chromatographie en phase gazeuse avec un détecteur à capture d'électron VARIAN (CP3380).
Dans la zone de Raoued 28 congénères ont été détectés dans les échantillons de sédiment des stations d'étude. Les teneurs en PCBs variant entre 7 et 175 ng/g PS avec une moyenne de51 ng/g PS.

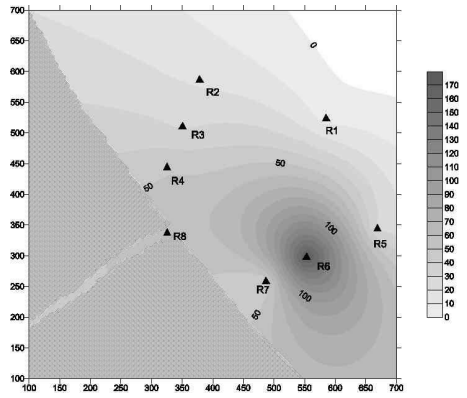


Fig. 1. Répartition spatiale des teneurs en PCBs (ng/gPS) au niveau du sédiment superficiel de la zone de Raoued.

La concentration la plus élevée a été mesurée au niveau de la station R6 situé à l'Est de l'embouchure de canal Khélij (Figure 1). Dans le site de Radès, nous avons mis en évidence la présence de 25 congénères de PCBs. Les concentrations de ces résidus varient entre 13 et 2668 ng/g PS avec une moyenne de l'ordre de 621 ng/ g PS. En analysant la répartition des résidus de PCBs dans la zone de Radès, nous avons constaté que l'accumulation de ces composés est plus importante au niveau de la station M3 situé au nord de l'embouchure d'oued Méliane alors qu'elle est plus faible dans la station M8 localisée à l'Est de l'embouchure (Figure 2). Les auréoles de fortes concentrations en PCBs ont été ainsi mises en évidence au large des embouchures du canal Khélij et de l'oued Méliane. Ce profil de distribution est essentiellement dépendant des courants dominants dans cette branche de côte.

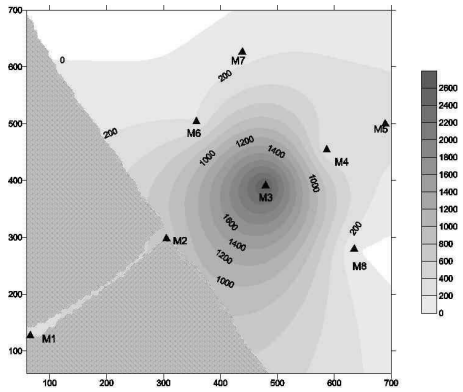


Fig. 2. Répartition spatiale des teneurs en PCBs (ng/g PS) au niveau du sédiment superficiel de la zone de Radès.

En interprétant nos résultats sur la base des PCBs totaux, nous notons que les niveaux détectés dans les zones étudiées sont comparables à ceux enregistrés dans d'autres travaux réalisés au niveau de la Méditerranée [2]. Toutefois les concentrations de PCBs enregistrées dans la zone de Radès sont significativement élevées par rapport à celles mesurées dans le sédiment de Raoued. Les rejets industriels véhiculés par l'oued Méliane sont probablement responsable de la forte contamination de la plage de Radès par ces organochlorés [3]. Le profil des PCBs selon le degré de chloration révèle que les pentachlorobiphényles sont prédominants dans toutes les stations étudiées, leur taux varie entre 22 et 41 %. Les octachlorobiphényles présentent les taux les plus élevés au niveau de la majorité des stations de la zone d'étude qui dépassent les 30% (34 – 51 %) sauf en M8 où leur taux est de l'ordre de 14 %. Cette dominance est due à la concentration élevée du PCB 200 dans presque toutes les stations de Radès. En conclusion, ce travail a permis de dresser un état des lieux de la contamination du sédiment du golfe de Tunis par les PCBs. Nous avons mis en évidence l'impact des rejets du canal Khélij et de l'oued Méliane chargés en micropolluants en provenance des stations d'épurations et des industries.

References

1 - AFNOR., 2000. Association Française de Normalisation. Dosage des hydrocarbures aromatiques polycycliques (HAP) et des Polychlorobiphényles (PCB). Normalisation française, XP X 33-012 mars 2000.

2 - Castells P., Parera J., Santos F.J. et Galceran M.T., 2008. Occurrence of polychlorinated naphthalenes, polychlorinated biphenyls and short-chain chlorinated paraffins in marine sediments from Barcelona (Spain). *Chemosphere*, 70 (9): 1552-1562.

3 - Masmoudi W., Romdhane M.S., Kheriji S. et El Cafsi M., 2007. Polychlorinated biphenyl residues in the golden grey mullet (Liza aurata) from Tunis Bay, Mediterranean sea (Tunisia). *Food. Chem.*, 105: 72–76.

THE INFLUENCE OF SUBMARINE WASTEWATER SYSTEM ON CHEMICAL AND BIOLOGICAL PARAMETERS IN THE WATER COLUMN AND SEDIMENT AT THE MIDDLE ADRIATIC (CROATIA)

S. Matijevic [1]*, G. Kuspilic [1], Z. Nincevic-Gladan [1], N. Krstulovic [1], N. Bojanic [1] and D. Bogner [1]
[1] Set. I. Mestrovica 63, P.O. Box 500, 21000 Split, Croatia - dosen@izor.hr

Abstract
To eliminate the inadequate disposal of wastewaters in the middle Adriatic area, which created negative impacts and long-term changes of chemical and biological parameters during the second half of the last century, Republic of Croatia provided collection of wastewaters and discharge through submarine outlets. This paper presents results of investigations of oxygen, nutrients, chl a concentrations, microzooplankton, bacterioplankton and fecal bacteria in the water column, sediment redox potential, organic matter, organic carbon content and granulometric composition in the submarine wastewater outlet located in the Brac Channel, near town of Split.

Keywords: Adriatic Sea, Coastal Waters, Nutrients, Organic Matter

Material and Methods

Samplings and measurements were obtained at 11 stations located along the submarine wastewater outlet in the Brac Chanell during the period prior to (2002-2004) and after the activation of the discharge (2004-2009). Dissolved oxygen in seawater samples was determined by Winkler titration, while inorganic and organic nutrients were determined colorimetrically [1]. Chlorophyll *a* (Chl *a*) concentrations were determined fluorometrically [2], number of heterotrophic and fecal bacteria was identified using flow citometry and membrane filtration culture method, respectively. Sediment samples were collected by gravity corer and redox-potential was measured "*in situ*" by vertical penetration of a Pt electrode with Ag/AgCl reference electrode. Organic matter content in sediments was determined gravimetrically, while organic carbon content was determined using a Carlo Erba CHNS-O analyzer. Granulometric composition of the sediment samples was determined by sieving and the hydrometric method.

Results and Discussion

Oxygen saturation in the water column during the entire investigated period (2002-2009) at all stations ranged from 76% to 120% and it did not show significant difference depending on the outlet activation time, but rather followed seasonal cycle of oxygen at the middle Adriatic coastal area. Vertical and temporal distribution of total inorganic nitrogen concentration (range: 0.2-8.9 mmol m^{-3}) were in accordance with values determined prior to activation of discharge and natural seasonal oscillations of nitrogen with ammonia as prevailing inorganic species. Distribution of orthophosphate concentrations (range: 0-0.77 mmol m^{-3}) showed occasionally enhanced values, particularly at station nearest to the outlet which can be attributed to the input of wastewater in the area. While number of heterotrophic bacteria showed significant decrease in relation to period prior to activation, biomass of phytoplankton expressed as chl *a* concentration (range: 0.07-1.07 mg m^{-3}) showed continually increase after the launching of the discharge. More obvious influence of the submarine wastewater input of organic matter was on sediment redox potential (Eh) and organic carbon content (C-ORG) in the surface layer (0-2 cm) (Fig. 1a,b). Prior to the outlet's activation, Eh at all investigated stations was mostly positive with short period of slightly negative values in 2003, which is probably part of the natural Eh oscillation as was reported for the middle Adriatic [3]. After the wastewater system's activation, from 2005 to 2009, medians of redox potential in the surface sediment layer of the entire investigated area were more negative (Fig. 1a), particularly at the stations nearest to the outlet (not shown on Fig.). C-ORG content at the all stations increased in relation to the period prior to activation (Fig. 1b) due to organic matter input and its accumulation in sediment. The observed changes in sediments are direct consequence of wastewater outlet and, considering the mechanical filtration of the effluents prior to discharge, the main impact to this marine environment occurs through dissolved inorganic and organic matter which can explain the observed delay in sediment response to anthropogenic input.

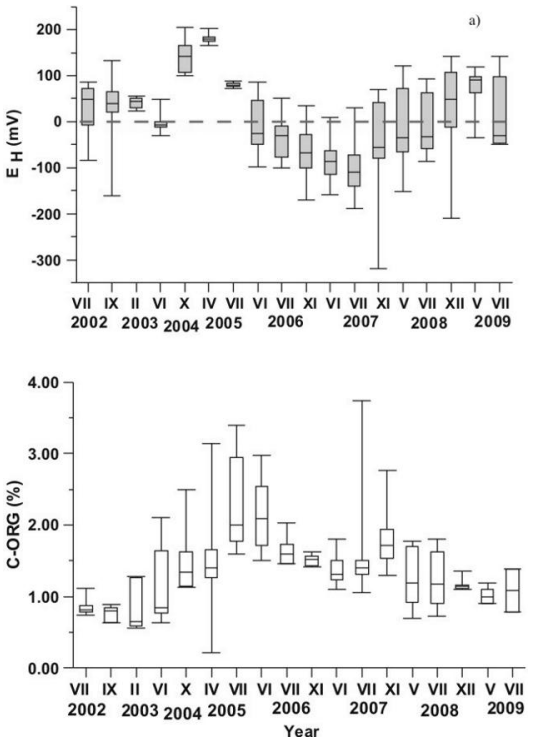


Fig. 1. Box- whisker plots of redox potential (a) and organic carbon content (b) in the sediment surface layer at investigated stations during 2002-2009

References

1 - Grasshoff K., 1976. Methods of Seawater Analysis, Verlag Chemie, Weinheim, 307 p.

2 - Strickland, J.D.H. & T.R. Parsons. 1972. A practical handbook of seawater analysis. *Bull. Fish. Res. Board Can.* 167: 1-310.

3 - Matijevic, S, G. Kušpilic & Z. Kljakovic-Gašpic. 2007. The redox-potential of sediment from the Middle Adriatic region. *Acta Adriat.* 48(2): 191-204.

ISOTOPIC COMPOSITION OF NITROGEN IN SUSPENDED PARTICULATE MATTER OF THE ALBORAN SEA

Jesús M. Mercado [1]*, Dolores Cortés [1], Teodoro Ramírez [1] and Esperanza Liger [2]
[1] Instituto Español de Oceanografía, Centro Oceanográfico de Málaga - jesus.mercado@ma.ieo.es
[2] University of Málaga

Abstract
The ^{15}N content of the particulate organic nitrogen (PON) suspended in the water column was determined during 4 seasonal surveys carried out in the northwest sector of the Alboran Sea (Mediterranean Sea). On average, the particulate matter in the mixed layer (ML) was enriched in ^{15}N by about 1.5‰ in fall and spring with respect to summer and winter. In spite of this seasonal cycle, ^{15}N relative content of PON in ML was correlated negatively with nitrate concentration suggesting that the mass-dependent isotopic fractionation associated to nitrate uptake by the phytoplankton was the main factor controlling the ^{15}N signature of PON.
Keywords: Alboran Sea, Carbon, Nutrients, Primary Production

Introduction
The ^{15}N:^{14}N ratio (usually expressed in per mil notation, $\delta^{15}N$) of the algal material is determined by the isotopic composition of the source nitrogen used by the phytoplankton (NO_3^-, NH_4^+ and N_2) and the fractionation associated to the assimilation processes (^{14}N is preferentially taken up by the phytoplankton). The isotopic fractionation during NO_3^- uptake results in ^{15}N depletion in the algal-N with respect to the source-NO_3^-. The cyanobacterial N_2 fixation also lowers the $\delta^{15}N$ of the algal material because of the lower $\delta^{15}N$ of the atmospheric N_2 (0 ‰). The reduced forms of N resulting of organic matter and their consumption deals with decrease of the $\delta^{15}N$ of the phytoplankton. In the study area, differences in f-ratio have been documented thought the seasonal cycle [1]. The objective of this work is to research which process could be more important in determining the signature of 15N in the algal material of the study zone.

Materials and Methods
Hydrological data and seawater samples were collected in 6 stations located at the Alboran Sea, Western Mediterranean Sea, during four cruises performed in July-2003, October-2003, February-2004 and May-2004. Samples of seawater were collected at 6 fixed depths within the upper 100 m layer, in order to measure nutrients and chlorophyll a. Content of organic nitrogen (PON) and carbon (POC) and nitrogen stable isotope natural abundance in the organic matter lower than 0.2 mm were also measured by using a FlashEA1112 (ThermoFinnigan) elemental analyzer connected to a Deltaplus (ThermoFinnigan) continuous flow isotope-ratio mass spectrometer. The isotopic abundances in the samples were normalized by the isotopic abundance in the standard (atmospheric N_2) and expressed in per mil notation ($\delta^{15}N$).

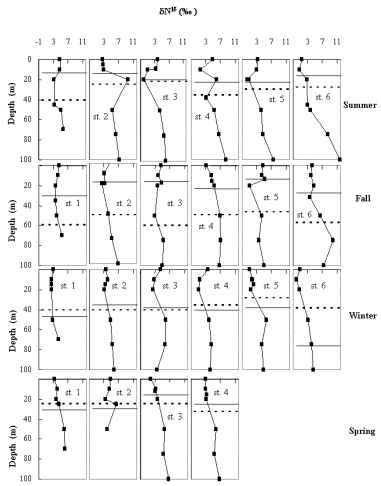


Fig. 1. Profiles of ^{15}N:^{14}N content of the organic mmater at the sampling stations during the four seasonal surveys

Results
Most of the profiles of POC and PON showed a maximum located within the upper 20-30 m layer. Contrastingly, the POC and PON maximums were situated in the surface during spring. In this upper layer, the spatial variability of POC and PON was remarkable, particularly in summer when the variation ranges for POC and PON were 300-50 and 50-10 $\mu g\ L^{-1}$, respectively. The organic matter concentration trended to decrease below ML until to reach the lowest value at 75-100 m depth. POC and PON concentrations averaged for ML were significantly higher in summer and spring than in fall and winter. The relative abundance of ^{15}N in the particulate matter collected throughout the study period ranged from –0.1‰ to 13‰. In most of profiles, $\delta^{15}N$ decreased just below the surface until to attain a minimum roughly coinciding with the lower limit of ML (Figure 1). Below this minimum, $_{\delta}{}^{15}N$ increased usually reaching the higher values at 75-100 m depth. The variation range of $_{\delta}{}^{15}N$ in ML was –0.1‰ to 6.5‰, with these low values being obtained in summer. On average, the particulate matter in this layer was enriched in ^{15}N by about 1.5‰ in fall and spring with respect to summer and winter. The variability of $_{\delta}{}^{15}N$ in ML was substantial during each survey, which was probably linked to the hydrological variability. In spite of that, $\delta^{15}N$ averaged for ML was negatively correlated with the nitrate concentration.

Discussion
The negative relationship between $\delta^{15}N$ of PON in the surface samples and nitrate concentration indicates that isotopic fractionation during N-uptake plays a major role in determining the $\delta^{15}N$ signature. The isotopic fractionation could also explain the vertical pattern of $\delta^{15}N$ of PON commonly observed in our study area, with values of $\delta^{15}N$ lowest at the base of the euphotic layer where NO_3^- is the highest, rising toward surface with decreasing NO_3^-. The lower values of $\delta^{15}N$ of PON were obtained in winter. Note that our data precludes the possibility of significant N_2 fixation. $\delta^{15}N$ values from -2‰ to 0‰ have been described for N_2-fixer cyanobacteria. Most of the $\delta^{15}N$ values obtained in our study are above 2‰ and all the samples in which $\delta^{15}N$ was below this threshold were collected at stations where the NO_3^- concentration was relatively high (which inhibits the N_2 fixation).

Acknowledgements: This work has been funded by the Spanish Ministry of Science and Innovation (Projects NITROALBORAN CTM2006-00426 and TROFOALBORAN CTM2009-07776, co-funded from EU)

References
1 - Mercado J.M., Ramírez T., Cortés D., Sebastián M., Liger E., Bautista B., 2008. Partitioning the effects of changes in nitrate availability and phytoplankton community structure on the relative nitrate uptake in the Northwest Alboran Sea (Mediterranean Sea). *Mar Ecol Progr Ser* , 359:51-68

SEASONAL AND INTERANNUAL PATTERNS OF 1000M DEPTH TRACE METALS FLUXES AT THE DYFAMED TIME-SERIES STATION (LIGURIAN SEA)

Christophe Migon [1]*, Lars-Eric Heimbürger [1], Remi Losno [2] and Juan-Carlos Miquel [3]

[1] (1) UPMC Université Paris 06, UMR 7093, LOV, Observatoire océanographique, F-06234, Villefranche-sur-mer, (France) (2) CNRS, UMR 7093, LOV, Observatoire océanographique, F-06234, Villefranche-sur-mer, (France) (3) IFREMER, Centre Nantes, BP 21109, F- - migon@obs-vlfr.fr

[2] LISA, Université Paris 7-Paris 12, CNRS, 61 Avenue du Général de Gaulle, F-94010 Créteil cedex (France)

[3] IAEA, Marine Environmental Laboratories, 4 Quai Antoine 1er, MC 98000 Monaco (Monaco)

Abstract

Sediment traps were moored at 1000m-depth at the DYFAMED time-series station (Ligurian Sea). 1990s and 2003-07 trace metal and mass flux data suggest that the transfer of atmospheric material is quantitatively driven by the magnitude and variability of biological production. Decadal trends are tentatively outlined, suggesting that the temporal variability of deep fluxes is modulated by the variability of external parameters that control winter convection and subsequent biological activity.

Keywords: Particle Flux, Trace Elements, Time Series, Ligurian Sea

In NW Mediterranean marine environments mainly constrained by atmospheric forcing, the accumulation of sinking particles presumably mirrors the evolution of anthropogenic emissions. Automated time-series sediment traps (Technicap PPS 5, equipped with a programmable 24-cup collector, sampling rate 15 days) were moored at the DYFAMED time-series station (Ligurian Sea, 43°25'N, 7° 52'E, 2350 m depth), in the frame of the French project COMET (COnstructing MEditerranean Time-series, LEFE programme). Owing to its circulation (permanent cyclonic gyre), the DYFAMED site is sheltered from lateral inputs, apart from exceptional conditions [1]. Trace metal (TM: Al, Fe, Mn, Ni, Cu, Cd, Pb, V, Zn) and mass fluxes were measured from March 2003 to March 2005. Archive data from deployments in the 1990s were used to estimate a possible decadal evolution. The seasonal pattern of mass and TM fluxes are compared in Fig. 1 for the case of Al and Pb. An outstanding feature is the strong covariance observed between mass flux and TM flux, whatever the nature of the TM (e.g., anthropogenic or crustal). This suggests that, apart from convection episodes associated with dense water formation, the transfer of atmospheric material is almost totally driven by the magnitude and variability of biological production. This statement is in agreement with previous studies that pointed out the prominent role of biological activity in the removal of TMs [2, 3]. The comparison of 1995 and 1997-98 data with 2003-07 data suggests decadal evolutions linked to changes in land-based emission sources. However, these findings are slightly different of the decadal evolutions observed in the atmospheric aerosol in the same region [4]. This presumably results from the interannual variability of external factors (temperature, wind stress, etc.) that determine the intensity of winter convection and, therefore, that of biological production, i.e. the driving force of atmospheric matter downward transfer.

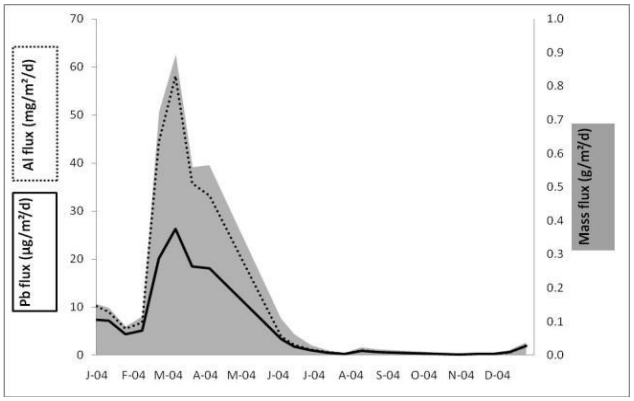


Fig. 1. Seasonal variability of mass, Al and Pb fluxes; 2004 as an example

References

1 - Lévy M., Mémery L. and André J.M., 1998. Simulation of primary production and export fluxes in the Northwestern Mediterranean Sea. *J. Mar. Res.* 56, 197-238.

2 - Buat-Ménard P., Davies J., Remoudaki E., Miquel J.C., Bergametti G., Lambert C.E., Ezat U., Quétel C., La Rosa J. and Fowler S.W., 1989. Non-steady-state biological removal of atmospheric particles from Mediterranean surface waters. *Nature* 340, 131-134.

3 - Migon, C., Sandroni, V., Marty, J.C., Gasser, B. and Miquel, J.C., 2002. Transfer of atmospheric matter through the euphotic layer in the northwestern Mediterranean: seasonal pattern and driving forces. *Deep-Sea Res. II* 49, 11, 2125-2142.

4 - Heimbürger L.E., Migon C., Dufour A., Chiffoleau J.F. and Cossa D. Evolution of trace metal concentrations in the Northwestern Mediterranean atmospheric aerosol between 1986 and 2008. Submitted to Sci. Total Environ.

THE SIGNIFICANCE OF ATMOSPHERIC INPUTS OF DISSOLVED AND PARTICULATE TRACE METALS TO THE EASTERN MEDITERRANEAN SEAWATER

Nikolaos Mihalopoulos [1]*, Christina Theodosi [1] and Zambia Markaki [1]
[1] Environmental Chemical Processes Laboratory, Department of Chemistry, University of Crete, 71003 Voutes, Heraklion, Crete, Greece - mihalo@chemistry.uoc.gr

Abstract
Atmospheric deposition is a potential source of trace metals of continental origin to oceanic areas. Trace metals speciation (Fe, Al, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Cd and Pb) was studied in atmospheric deposition (wet and dry) collected at a remote location in the Eastern Mediterranean Sea. Elemental concentrations were measured using ICP-MS, while Dissolved Reactive Fe (DSRFe: Fe (II) and Fe(III)) was determined spectrometrically. Atmospheric deposition was also compared with long-term trace metals data in sediment traps.
Keywords: Eastern Mediterranean, Atmospheric Input, Sediments, Metals

Introduction
The atmosphere is a significant source, especially for oligotrophic oceanic areas and semi-enclosed seas, such as the Mediterranean, due to the relative proximity of land-based sources and densely populated shores [1]. Riverine inputs are limited and localized and will not affect offshore sites such as the Cretan or the Levantine sea [2]. Thus atmospheric input may play an important role in the supply of bioavailable nutrients to surface waters and hence marine biological productivity. Therefore a comparison between dry and wet deposition of metals would be noteworthy regarding the bioavailability and toxicity of metals in the marine system.

Materials and Methods
Atmospheric deposition samples, wet and dry, were collected at Finokalia (35°20?N, 25°40?E), a remote coastal site in the Northeast part of Crete, in the Eastern Mediterranean over a two year period (January 2005–December 2006). After collection all samples were filtered through pre weighed 0.45 μm nitrocellulose filters. The sediment traps were moored for seven years in the Southern Cretan Sea (along 45°06?E, 500m and 1715m depth). The sediment trap samples were collected from 1999 until 2005, on a two–week basis and immediately after collection an aliquot was filtered through a precombusted and pre-weighted quartz fiber filters (Whatman QMA, diameter 47mm) for further analysis. An acid microwave digestion procedure followed by Inductively Coupled Plasma Mass Spectrometry was applied to measure metal concentrations in sediment trap and deposition samples.

Results and Discussion
Partitioning of atmospheric deposition between soluble and insoluble fractions demonstrated that Fe, V, Cr and Pb are mainly in the particulate form. For Cd, Zn, Mn and Cu, the dissolved fraction represents 60-68% of the total atmospheric input. Mean solubility for all metals in both wet and dry deposition appears to be related to pH and dust mass. More precisely solubility is decreasing with increasing pH values and increasing dust mass. For Pb, when the dust load is 0-70mg m^{-2} solubility reaches up to 74%, whereas dust >500mg m^{-2} leads to much lower Pb solubility is 0.3%. Cr, Mn and Cu are removed from the Eastern Mediterranean atmosphere by dry deposition, while Zn and Fe almost equally by wet and dry deposition whereas the rest of the studied metals via wet deposition.

In sediment traps, a significant correlation was observed between mass fluxes at 600m and 1715m indicating a quite good homogenicity in our system. Total mass flux presents two maxima: The first during spring, while the second one during autumn. Both are due to the increase in productivity and deposition of atmospheric dust. Similar seasonal trend was observed for Fe and Pb, elements characteristic of crustal and anthropogenic sources respectively, indicating similarity in transport mechanism independent of the trace metals origin. Dust is the main component of the sediment material as it accounts for about 40-44% of the mass. In addition a coherence between marine and atmospheric dust fluxes was observed. Annual deposition of atmospheric dust and dust in sediment traps are equal, in terms of fluxes, suggesting that atmospheric dust can be transferred in full down to 600 and 1715m.

Regarding the trace metals, our results suggested that atmospheric deposition is sufficient to balance their levels in the water column, indicating the predominant role of atmospheric deposition as external source of these elements in the area. Indeed DSRFe levels deposited were sufficient to account for the dissolved iron levels in seawater, therefore dissolved iron in the Mediterranean Sea could be exclusively attributed to atmospheric deposition. Cr, Mn, Fe, Zn, and Pb atmospheric deposition supplies 57- 84% of the amount collected in sediment traps. Total atmospheric depositions of Cu, Ni and Cd are equal to the fluxes from sediment trap deployment.

References
1 - Duce, R. A. and Tindale N. W., 1991. Atmospheric transport of iron and its deposition in the ocean. *Limnology and Oceanography*, 36, 17 15-I 726.
2 - Statham, P. J., Hart, V., 2005. Dissolved Iron in the Cretan Sea (Mediterranean). *Limnolology and Oceanography*, 118–124.

COUPLING BETWEEN ATMOSPHERE AND SEAWATER IN BLACK SEA: AN INTERGRATED APPROACH

N. Mihalopoulos [1]*, C. Theodosi [1], I. Stavrakaki [2], S. Stavrakakis [2], G. Kambouri [2] and S. Moncheva [3]
[1] UNIVERSITY OF CRETE - mihalo@chemistry.uoc.gr
[2] HELLENIC CENTRE FOR MARINE RESEARCH
[3] Institute of Oceanology, BAS

Abstract

The current study presents a complete data set of major and trace metals, organic and elemental carbon in sediment traps deployed in the South Western Black Sea. In addition data on atmospheric deposition of major and trace elements have been simultaneously obtained in a seaside resort on the Bulgarian Black Seas Coast. Atmospheric lithogenic mass fluxes accounts for 53- 65% of the lithogenic material in sediment traps. In general in sediment traps the lithogenic part was found to be the most abundant fraction (40%) followed by POM and carbonates (about 20-23% each). EC and others (probably opal material) accounted for the remaining %.

Keywords: Atmospheric Input, Black Sea, Sediments, Metals, Carbon

Introduction

For the area under investigation, Black Sea, the chemical composition of atmospheric deposition and sediment trap samples will be discussed. In total 48 sediment trap and 18 atmospheric deposition samples have been collected and analyzed for the major and trace metals (Al, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Cd and Pb), while sediment traps have been in addition analyzed for organic and elemental carbon. The aims of this study are to evaluate the seasonal variability of atmospheric deposition and settling material in Black sea and moreover the role of atmospheric deposition on Black Sea major and trace metals levels.

Materials and Methods

The sediment traps were deployed in the South Western Black Sea (43º01,812N 29º28,498E) at two depths (930m and 1930m) during the period October 2007 to December 2008. The sediment trap samples were collected, on a two–week basis and immediately after collection an aliquot was filtered through a precombusted and pre-weighted quartz fiber filters (Whatman QMA, diameter 47mm) for further analysis. Atmospheric deposition samples were collected at a seaside resort on the Bulgarian Black Seas Coast in Varna close to the sediment trap area. The samples were collected on a monthly sampling interval from March 2008 to April 2009 using the technique described by [2]. After collection all samples were filtered through 0.4 µm Millipore polycarbonate filters.

An acid microwave digestion procedure followed by Inductively Coupled Plasma Mass Spectrometry was applied to measure metal concentrations (Al, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Cd and Pb) in sediment trap and deposition samples. In addition sediment trap filters were analyzed for Organic and elemental carbon (OC and EC), with the Thermal-Optical Transmission (TOT) technique [1].

Results and Discussion

The temporal variations of mass fluxes present a seasonal pattern: Lower fluxes occurred from January to March, whilst higher fluxes from November to December for both depths (Figure 1,2). The percentage of OC in sediment traps at the two depths (930m and 1930m) was found to be 10 and 11%, respectively. Carbonates have been also measured and they account for 22 and 23% of the total mass at the two depths. The lithogenic part was estimated using Fe as a crustal tracer and was found to vary between 40 and 38% at 930 and 1930m, respectively. A detailed comparison between atmospheric deposition and sediment trap fluxes of elements is presented and discussed in this work.

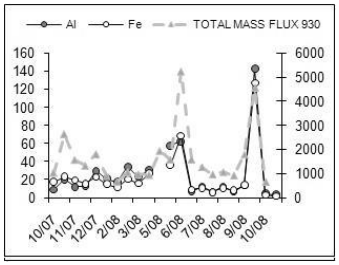


Fig. 1. Seasonal variations of total mass fluxes (mg m^{-2}) and of lithogenic origin elements

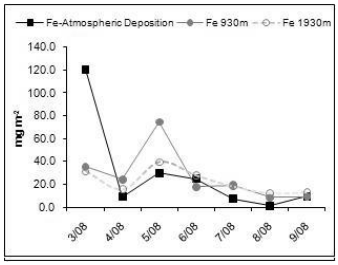


Fig. 2. Comparison between the fluxes of Fe (in mg m^{-2}) for both deposition and sediment traps

References

1 - Birch, M.E., and Cary, R.A., 1996. Elemental carbon-based method for monitoring occupational exposures to particulate diesel exhaust. *Aerosol Science and Technology,* 25, 221-241.

2 - Markaki, Z., Loÿe-Pilot, MD, Violaki, K., Benyahya, L., Mihalopoulos, N., *2008*. Variability of atmospheric deposition of dissolved nitrogen and phosphorus in the Mediterranean and possible link to the anomalous seawater N/P ratio. *doi:10.1016/j.marchem.2008.10.005.*

AN ACTIVE BIOMONITORING OF ORGANOCHLORINATED COMPOUNDS IN THE EASTERN ADRIATIC COASTAL WATERS (CROATIA) USING CAGED MUSSELS

Vesna Milun [1]*, Bruno Andral [2] and Francois Galgani [3]
[1] Institute of Oceanography and Fisheries, Šetalište I.Meštrovica 63, 21000 Split, Croatia - milun@izor.hr
[2] IFREMER, Laboratoire LER/PAC, ZP de Bregaillon, BP 330, 83507 La Seyne/mer, France
[3] IFREMER, Laboratoire LER/PAC, ZP de Bregaillon, BP 330, 83507 La Seyne/mer, France

Abstract
Within the framework of the MEDICIS programme, the regional project MYTIAD was undertaken in May-July 2008 to assess contamination along the coast of western and eastern Adriatic Sea. This research was a part of an interregional coastal water quality monitoring network in the Mediterranean basin based on active biomonitorig using caged mussels. In this paper, the distribution and levels of organochlorinated compounds (OCs) along Croatian part of the Adriatic Sea are presented. The possible influence of physiological parameters on OCs levels has been statistically examined.
Keywords: Adriatic Sea, Bivalves, Ddt, Pcb, Monitoring

Introduction
Since 1970s monitoring programmes were carried out to assess the quality of coastal environment. Therefore mussels have been successfully used as a good space and time-integrator of bioavailable contaminant fraction in the water. Active biomonitoring, i.e. transplantation of mussels from the same site and same population, provides comparable biological samples reducing possible sources of variation in the bioaccumulation process. Besides environmental parameters the resulting bioaccumulation in mussels is influenced by many physiological parameters such as lipid content and growth.

Materials and Methods
Using well-tested transplantation and caging technique [1], mussels of Italian origin, 16 month old and 50 mm length were immersed in plastic cages between 20 and 50 m at 12 locations along eastern Adriatic coast in May 2008 (Fig. 1). Mussel samples were collected after three months of immersion. Duplicate composite tissue samples (20 specimens) were freeze-dried, homogenized and Soxhlet extracted. The extracts were cleaned-up by concentrated sulphuric acid and passed through a florisil column for OCs separation. PCBs (IUPAC No. 28, 52, 101, 118, 138 and 180) and p,p'-DDTs were determined by GC-ECD.

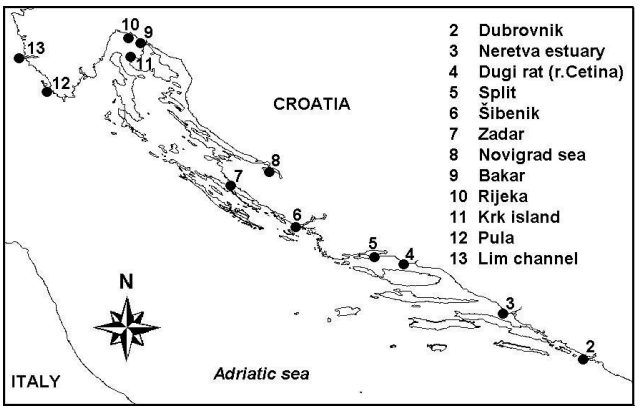


Fig. 1. Sampling locations of caged mussels along eastern Adriatic coast (Croatia).

Results and Discussion
The distribution pattern of OCs in the eastern Adriatic coastal waters (Croatia) was characterized by higher PCBs level in relation to DDTs (Fig. 2). PCBs concentrations ranged from 11 to 51 ng/g dw with the prevalence of congeners 153 (42%) and 138 (28%,) followed by PCB 118 (12%) and PCB 101 (8%). The elevated PCBs concentration was found near urbanized and industrialized centres (Dubrovnik, Split, Bakar, Rijeka) with high wastewaters input. The concentrations of DDTs were low, ranging from 2.3 to 6.0 ng/g dw, being spatially almost uniformly distributed. p,p'-DDE metabolite dominated with mean amount for 66% of total p,p'-DDTs followed by p,p'-DDD (23%), suggesting a lack of recent DDT input into the research area.

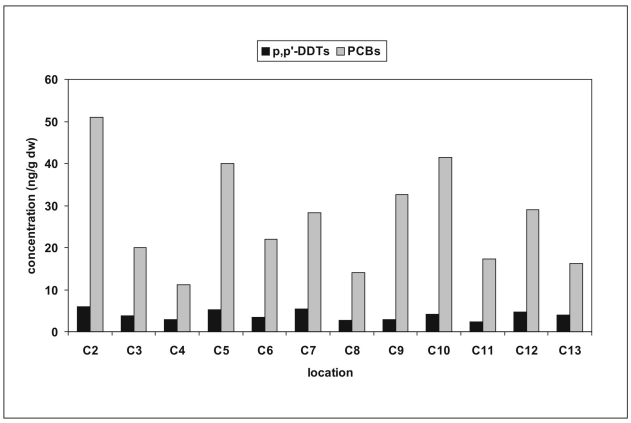


Fig. 2. Spatial distribution of p,p'-DDTs and PCBs concentrations at study area.

Statistical analysis revealed poor PCBs and moderate DDTs positive relationship with the percentage of hexane-extractable organic matter. Both PCBs and DDTs correlated positively and moderately with condition index of mussels. The OCs differences found in mussels were being primary influenced by local sources of contamination rather than physiological parameters. The ratio of the contaminant concentration in mussels after and before immersion was lower than 1, indicating an adjustment of contaminant levels during the 3 months experiment. Then, the levels of target organic contaminants found in caged mussels were generally lower than those published for native mussels on the coast, being within the range of values usually found in low to moderately contaminated marine coastal areas [2]. The mussel transplantation can be useful and reliable technique for large spatial monitoring. This study pointed out the importance of collecting the initial mussels from a relatively clean area in order to achieve optimal monitoring results.

References
1 - Andral B., Stanisiere J.Y., Sauzade D., Damier E., Thebault H., Galgani F. and Boissery P., 2004. Monitoring chemical contamination levels in the Mediterranean based on the use of mussel caging. *Mar. Pollut. Bull*., 49: 704-712.
2 - Milun V. and Zvonaric T., 2008. Monitoring of chlorinated pesticides and PCBs in the eastern Adriatic coastal waters using mussels *Mytilus galloprovincialis* as indicator. *Fresen. Environ. Bull*., 17:1891-1900.

THE EFFECT OF SHELLFISH FARMING ON THE WATER COLUMN NUTRIENT CONCENTRATION OF THE EASTERN MEDITERRANEAN

Nikos Neofitou [1]*, Nikos Charizopoulos [1], Dimitris Vafidis [1] and Labrini Tziantziou [1]
[1] University of Thessaly, School of Agriculture, Department of Ichthyology and Aquatic Environment - nikneof@uth.gr

Abstract
The effect of shellfish farming on the water column was investigated seasonally at a longline mussel farm (*Mytilus galloprovincialis* L.) of Maliakos Gulf, between October 2007 and July 2008. Nitrite and phosphate values showed significant differences among sampling stations and seasons ($p<0.05$ and $p<0.001$, respectively). Furthermore, in most cases concentrations of all nutrients and chl *a* at the farm site was lower than those observed at the control site. This indicates that shellfish farming contributes to the reduction of the primary production of Maliakos Gulf and consequently to the risk of eutrophication.
Keywords: Aquaculture, Mollusca, Coastal Waters, Nutrients, Aegean Sea

Introduction
Annual world harvest of wild mussel stocks has increased during the past 20 years and has led to overexploitation of natural beds. Mussel aquaculture is consequently an expanding industry. The impact of aquaculture on the concentration of nutrients in the Eastern Mediterranean has been addressed in a number of studies [1]. The environmental effects of mussel farming, where no excess food is supplied, are supposed to be much less than those of caged fish farming. However, relatively little is known of the effects of longline mussel farming on nutrient dynamics [2]. The objective of this study was to assess the effects of longline mussel farming on nutrient concentrations of Maliakos Gulf.

Materials and methods
The study was carried out in the Maliakos Gulf, central Greece, at a shellfish farm (38º50'99'' N 22º36'48'' E) between October 2007 and July 2008. Mussel (*Mytilus galloprovincialis* L.) was intensively cultivated in this farm. Two stations were sampled. The first was located at the centre of the mussel farm and the second at a distance of 500 m from the mussel farm center, referred as farm and control site, respectively. Vertical profiles of temperature, salinity, dissolved oxygen (DO) and chl *a* were measured at each sampling station by means of a CTD (SEABIRD-19plus). For nutrient analysis, samples were collected by means of a 1 L Niskin bottle at the surface, 5 m and 20 m depth from the surface to the bottom. From both sampling stations, five replicate samples were taken during all seasons, in order to determine natural variability within replicates (120 total samples). The water samples were placed in 250 ml plastic vials where mercury chlorine (1 ml $HgCl_2$ per 1 L sample) was added in order to neutralize the bacterial and other photosynthetic organisms [3]. Samples were stored at -20 ºC until analysis took place with a spectrophotometer (SHIMADZU UV-1700) according to the procedure described by [3].The one-way nested analysis of variance (ANOVA) was used to analyze the effect of station and season on variations in chemical parameters.

Results and discussion
Physicochemical characteristics of both studied sites are summarized in Table 1. These results shows that almost in all cases the minimum, maximum and the mean concentration of the physicochemical characteristics was lower at the farm site compared to the control site. The above indicates the positive effect of shellfish farming on the water column nutrient concentration. The quantity of nutrients removed by shellfish harvest can be quite large [4]. Filter-feeding molluscs not only remove N from the water column, but also incorporate a high proportion of it into their tissues. When the molluscs are harvested, the N is removed from the system [5]. Shellfish feeding can also help to control or even prevent harmful algal blooms by removing the cells before the algae accumulate to environmentally detrimental levels [5]. During the course of this study, we concluded that shellfish farming is, by definition, a 'green' industry which plays a vary important role in the ecological system of Maliakos Gulf

Tab. 1. Minimum, maximum and mean ± standard error of physicochemical parameters of both studied sites.

Parameter	Farm site	Control site
Dissolved oxygen (mg L^{-1})		
Range	4.65-8.42	4.77-8.53
Mean ± SE	6.49 ± 0.05	6.74 ± 0.04
NH_4 (µM)		
Range	0.16-6.87	0.01-10.33
Mean ± SE	1.44 ± 0.26	1.90 ± 0.35
NO_2 (µM)		
Range	0.03-0.80	0.07-0.83
Mean ± SE	0.35 ± 0.03	0.32 ± 0.03
NO_3 (µM)		
Range	0.99-14.42	3.68-10.40
Mean ± SE	7.61 ± 0.54	7.66 ± 0.35
PO_4 (µM)		
Range	0.05-5.56	0.02-9.75
Mean ± SE	1.88 ± 0.29	2.38 ± 0.42
SiO_2 (µM)		
Range	4.92-32.15	5.52-36.12
Mean ± SE	12.57 ± 1.03	14.55 ± 1.29
Chl *a* (mg/m^3)		
Range	0.62-12.45	0.53-13.85
Mean ± SE	4.84 ± 0.13	5.00 ± 0.13

.

References
1 - Neofitou N. and Klaoudatos S., 2008. Effect of fish farming on the water column nutrient concentration in a semi-enclosed gulf of the Eastern Mediterranean. *Aquac. Res.*, 39: 181-194.
2 - Christensen P.B., Glud R.N., Dalsgaard T. and Gillespie P., 2003. Impacts of longline mussel farming on oxygen and nitrogen dynamics and biological communities of coastal sediments. *Aquac.*, 218: 567-588.
3 - Eaton D.A., Clesceri L.S. and Greenberg A.E., 1995. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, 19th Edition, Washington, USA.
4 - Tucker C.S. and Hargreaves J.A., 2008. Environmental best management practices for aquaculture. Blackwell Publishing, Ames, Iowa, USA, 592 pp.
5 - Shumway S.E., Davis C., Downey R., Karney R., Kraeuter J., Parsons J., Rheault R. and Wikfors G., 2003. Shellfish aquaculture – In praise of sustainable economies and environments. *World Aquac.*, 34: 8-10.

TOXICITY-CHEMISTRY RELATIONSHIPS IN SEDIMENTS COLLECTED FROM BLACK SEA

R. Oral [1]*, B. Buyukisik [1], F. Kucuksezgin [2], E. Y. Ozkan [1] and E. Darilmaz [2]
[1] Ege University, Faculty of Fisheries - rahime.oral@ege.edu.tr
[2] Dokuz Eylul University, Institute of Marine Sciences and Technology, 35340 Izmir, Turkey

Abstract
This research investigated the spatial distribution of chemical contamination and toxicity of marine surfacial sediments collected from six sites along the Turkish coast in Black Sea. Sediment toxicity to sea urchin (*Paracentrotus lividus*) embryonic development was evaluated with whole sediment specimens. Concurrently, sediment samples were analyzed for their chemical characterisation to evaluate toxicity data.

Keywords: Ecotoxicology, Sediments, Black Sea, Petroleum, Metals

Introduction

It is dificult task to make a desicion about toxicity of sedimentary contaminats to aquatic organisms. Bioassays are routenely used for sediment quality evaluation. Among these sea urchin embryotoxicity bioassays are recognized as reliable, sensitive and ecologically important tools for evaluating marine and estuarine environmental quality [1- 2]. The goals of this sudy were to determine concentration of metals and petroleum hydrocarbons in Black Sea sediments and relationships between contamination and biological effects.

Material and Methods

Sediment samples collected from six sites along the Turkish coast in Black Sea (Istanbul, Eregli, Inebolu, Sinop, Ordu, Trabzon) by using core sampler. Surface sediment samples were taken from upper 2cm. depth for chemical and toxicological analyses.

Determination of petroleum hydrocarbons were made by GC-FID according to UNEP [3]. 0.2g dry sediment samples were digested with HCl,HNO_3,$HClO_4$,HF acid mixture. Differantial Pulse Anodic Stripping Voltametry (DP-ASV) was used for Cu ,Pb and Zn by using Metrohm Voltammeter model 797VA Computrace according to Metrohm VAApplication Work AWUK4-0134-042002. C^{14} dating was made in Beta Analitic Inc.

The embryotoxicity test with sea urchin (Paracentrotus lividus) embryos was performed using the procedure reported in detail in before [1]. Bioassays were carried out in by evaluating the following endpoints: a) normal (N) pluteus larvae; b) retarded (R) plutei, with size <1/2 N, yet no evident abnormalities; c) malformed plutei (P1) exhibiting a number of skeletal or other abnormalities; d) developmentally arrested embryos (P2), i.e. unable to undergo larval differentiation (blastulae or gastrulae), and e) dead (D) plutei (D1) or early embryonic death (D2).

Results and Discussion

Bioassay with sea urchin showed that the highest embryotoxicity was exerted by the sediment from Istanbul (P1+P2 = 100 %) compared to controls (P1+P2 @ 3,5%). Sediments from Zonguldak and Inebolu displayed significantly higher developmental toxicity while the other sediment samples failed to show any significant difference compared to blank controls (Table1).

Tab. 1. Developmental toxicity of sediment samples collected from Turkish coast in Black Sea. % Developmental defects in *P. lividus* larvae, means ± SEM.

Sampling Site	N	P1	P2	P1+P2	value
Blank Control	96,5±0,9	2,7±0,7	0,3±0,2	3,0±0,8	
Positive Control ($CdSO_4$ 2.5X10^{-4}M)	0,0±0,0	0,0±0,0	100,0±0,0	100,0±0,0	,000
Istanbul	0,0±0,0	94,5±3,5	5,5±2,2	100±0,0	,000
Zonguldak	77,3±3,4	21,8±3,5	0,8±0,5	22,5±3,6	,000
Inebolu	78,3±3,1	20,8±3,2	0,3±0,3	21,2±3,1	,000
Sinop	89,5±0,4	10,2±0,5	0,5±0,5	10,5±0,4	,000
Ordu	92,7±1,3	7,3±1,3	0,0±0,0	7,3±1,3	,010
Trabzon	93,8±1,2	5,8±1,2	0,0±0,0	5,8±1,6	,076

The concentrations of petroleum hydrocarbons, metal and % organic carbon of sediment samples are given in Table2. Readman et al., [4] was reported 6,4 ng/g naphtalane concentration in Bosphorus (Istanbul) sediment samples. This result consistent with present data measured in Istanbul (7,0 ng/g). ΣPAH levels of all stations were much smaller than ERL value of 4122 ng/g. It has not been expected toxicity from ΣPAH value. The aliphatic hydrocarbon, n-C_{17} concentrations was significantly related to % developmental defects of sea urchin (R^2=0,84). Bioaccumulation dynamics of aliphatic hydrocarbons in detritivoros fishes and codding feed crude oil controlled by an efficient molecular discrimination during intestinal absorbtion. Higher bioaccumulation factors has been found in the range of betwee n-C_{15} and n-C_{17} [5]. It was suggested that the correlations were probably related to hydrophobocity and bioaccumulation factors of n- alkanes like fishes. Trace metal concentrations was not correlated with toxicity data. The only station Zonguldak was not exceeded the ERL values according to metals. Suddenly drops of Cu and Pb in Zonguldak was due to the fact that surface sediment layer dated to 1780±40BP (calculated AD 130-350)

Tab. 2. Petroleum hydrocarbons and some metals concentrations in six sediment specimens from Black Sea and ERL guideline values (Effects-Range-Low). All HC values are as ng/g.

lifatique	Istanbul	Zonguldak	Inebolu	Sinop	Ordu	Trabzon	ERL
-C_{10}	377	120	232	73	148	550	
-C_{12}	1669	511	614	435	742	2387	
-C_{14}	1457	484	598	337	697	2012	
-C_{16}	813	181	218	121	219	956	
-C_{17}	309	107	135	129	nd	Nd	
rystane	177	37	151	87	nd	Nd	
-Octadecene	14	11	Nd	23	33	71	
-C_{18}	406	140	89	76	85	483	
hytane	14	nd	61	nd	nd	Nd	
-C_{20}	92	1	124	85	6	218	
-C_{21}	1261	128	1017	173	234	198	
-C_{22}	93	37	68	27	33	133	
-C_{24}	111	40	nd	257	75	nd	
-C_{26}	170	nd	25	29	39	7	
qualane	179	nd	nd	nd	75	10	
-C_{27}	515	106	218	236	363	233	
-C_{30}	390	9	7	33	nd	6	
-C_{32}	218	nd	51	94	110	90	
-C_{34}	194	nd	40	208	130	nd	
-C_{17}/Pry	2	3	1	1	-	-	
-C_{18}/Phy	30	-	1	-	-	-	
dd Numbered -HC	2262	377	1520	625	597	437	
$_{17+}$ ΣC_{21}-C_{34}	3441	427	1561	1186	1059	677	
ven Numbered -HC	6196	1534	2127	1799	2393	6922	
otal Aliphatique	8459	1911	3647	2424	2990	7353	
ry/Phy	13	-	2,5	-	-	-	
romatique	KD01	KD02A	KD03	KD04	KD05A	KD06	
laphthalene	7	78	28	nd	nd	25	160
-MethylNaphthalene	nd	7	29	46	17	nd	
-Ethyl Naphtalene	nd	nd	nd	nd	nd	nd	
cenaphthylene	nd	nd	nd	nd	nd	nd	44
cenaphtene	nd	nd	nd	nd	nd	nd	16
luorene	nd	nd	nd	nd	nd	nd	19
henanthrene	nd	nd	nd	nd	nd	nd	240
nthracene	nd	nd	nd	nd	nd	nd	85,3
-methylphenanthrene	nd	nd	212	151	227	nd	
-methylphenanthrene	nd	nd		nd	nd	nd	
-6dimethylphenantren	nd	nd	227	nd	nd	nd	
luoranthene	nd	247	nd	nd	nd	nd	600
yrene	nd	33	nd	nd	nd	nd	665
-methylpyrene	nd	nd	nd	nd	nd	nd	
hrysene	nd	nd	nd	nd	nd	nd	384
erylene	nd	139	4		11	nd	
enzo(a) anthracene	nd	nd	nd	nd	nd	nd	261
enzo(b)fluorantene	nd	nd	nd	nd	nd	nd	
enzo(k)fluorantene	nd	nd	nd	nd	nd	nd	
enzo(e)pyrene	nd	nd	177	112	142	153	
enzo(a)pyrene	nd	nd	348	129	158	221	430
deno)1,2,3-cd) pyrene	nd	nd	nd	nd	nd	nd	
iBenzo(a,h)anthracene	nd	nd	nd	nd	nd	nd	63,4
enzo(g,h,i)perylene	nd	nd	nd	nd	nd	nd	
eP/BaP	-	-	1	1	1	1	
PAH	7	505	1024	437	555	399	4022
otalOrg.C mg/g	22.1	4.3	11.3	18.6	15.4	18.4	
n µg/g	210.5*	137.0	116.0	141.8	137.4	203.8*	150
b µg/g	79.6*	17.8	52.1*	204.0*	69.4*	58.3*	46.7
u µg/g	82.1*	9.4	36.6*	68.8*	78.0*	51.1*	34

: Concentrations exceeded ERL values

Acknowledgments

This research was supported by TUBITAK (The Scientific and Technological Research Council of Turkey) Project No: 107Y182.

References

1 - Pagano G, Korkina LG, Iaccarino M, De Biase A, Deeva IB, Doronin YK, Guida M, Melluso G, Meriç S, Oral R, Trieff NM, Warnau M, 2001. Developmental, cytogenetic and biochemical effects of spiked or environmentally polluted sediments in sea urchin bioassays. i*n*: Garrigues P, Walker CH, Barth H (eds) Biomarkers in marine ecosystems: A practical approach. Elsevier, Amsterdam, pp 85-129.

2 - Volpi Ghirardini A., Arizzi Novelli, A., Losso, C. and Ghetti, P.F., 2003. Sea urchin toxicity bioassays for sediment quality assessment in the Lagoon of Venice (Italy). *Chem. Ecol.*, **19** 2–3, pp. 99–111.

3 - UNEP, 1992, Reference method No:20, INEP / IOC / IAEA: Determination of petroleum hydrocarbons in sediments.

4 - Readman J.W., Fillman G., Tolosa I., Bartocci J., Villeneuve J-P., Catinni C., Mee L.D., 2002).Petroleum and PAH contamination of The Black Sea, *Ma.r Pollu. Bull.*, 44:48–62.

5 - Colombo J.C., Cappelletti N., Migoya, M.C. and Speranza E., 2007. Bioaccumulation of anthropogenic contaminants by detritivorous fish in the Riodela La Plata estuary: 1- Aliphatic hydrocarbons. *Chem.*, 68: 2128-2135.

I-129 LEVELS IN MARINE ENVIRONMENT ALONG THE SLOVENIAN COAST

Andrej Osterc [1]* and Vekoslava Stibilj [1]
[1] Institute Jožef Stefan - andrej.osterc@ijs.si

Abstract

^{129}I is considered as a global pollutant and its role as a global tracer to follow the dissemination of radionuclides from a source point such as nuclear power reprocessing plants increases. A radiochemical neutron activation analysis method was developed to measure the concentration of ^{129}I in environmental and biological samples. The method was validated using the IAEA-375 Soil, FC98 Seaweed and NIST 4357 Ocean Sediment. The method was applied to analyze $^{129}I/^{127}I$ isotopic ratios in the marine environment of Slovenia. The results found were in the range from 1.3 to $55.4 \cdot 10^{-9}$ μq g^{-1} for seawater, from 104 to $127 \cdot 10^{-9}$ μq g^{-1} for blue mussel, from 334 to $471 \cdot 10^{-9}$ μq g^{-1} for alga *Fucus virsoides* and from 72 to $256 \cdot 10^{-9}$ μq g^{-1} for marine sediment.

Keywords: Algae, Coastal Waters, Fallout, Radionuclides, Sediments

1 Introduction

The only stable natural iodine isotope is ^{127}I and the total amount of this element in the Earth's crust was estimated to be $8.6 \cdot 10^{15}$ kg of which nearly 70 % resides in marine sediments and 28 % in sedimentary rocks. The marine environment, i.e. the oceans, is the major source of iodine with average concentrations of around 60 μg L^{-1} iodine in seawater. The biogeochemical cycling of iodine is driven with its volatilization from oceans and soil to the atmosphere in the form of iodinated hydrocarbons of which methyl-iodide predominates. From the atmosphere the iodine is washed out to the marine and terrestrial environment by wet (precipitation) and dry (aerosol) depositions [1].

^{129}I ($T_{½} = 1.57 \cdot 10^7$ years) is the only natural radioactive isotope of iodine, which is formed in nature by two processes. The cosmogenic ^{129}I is produced in the atmosphere by the interaction of cosmic rays with xenon isotopes and the fissiogenic ^{129}I by spontaneous fission of uranium in the lithosphere. For the pre-nuclear era (no addition of anthropogenic ^{129}I to the environment) an $^{129}I/^{127}I$ isotopic ratio of about $1.5 \cdot 10^{-12}$ has been estimated. The quantity of ^{129}I in the pre-nuclear age ocean was ~100 kg. Since 1945 anthropogenic production of ^{129}I started which shifted the natural isotopic ratio for 3 to 6 orders of magnitude in favour of ^{129}I.
The main sources of ^{129}I are nuclear fuel reprocessing plants.

To our knowledge the ^{129}I level has not been measured in any biological or environmental sample from the Mediterranean area (Adriatic Sea). The aim of our work was to investigate the distribution of ^{129}I in the marine environment of Slovenia.

2 Methodology

2.1 Sampling and preparation
First sampling of alga (*Fucus virsoides*) and sediment was performed in 2005 and another sampling in 2009 including seawater, alga (*Fucus virsoides*) and blue mussel (*Mytilus galloprovincialis*). Alga and blue mussel were dried by freeze dryer to constant mass and homogenized. Seawater and sediment samples were analysed as collected.

2.2 Determination of ^{129}I and ^{127}I
Radiochemical neutron activation analysis method (RNAA) was used for the determination of ^{129}I [2] and ^{127}I [3] in environmental samples. Environmental samples contain very low amounts of ^{129}I therefore pre-concentration of iodine from up to 100 g of alga, blue mussel and sediment and up to 8 L of seawater are needed. Irradiation of sample, combustion in an oxygen atmosphere and extraction of iodine with $CHCl_3$ followed. Induced radioisotopes were measured on a HPGe detector. The chemical yield for the whole procedure was determined spectrophotometrically and by using the ^{126}I activity.

3 Results and Discussions

The method was applied to analyze $^{129}I/^{127}I$ isotopic ratios as well as ^{129}I and ^{127}I concentrations in the marine environment of Slovenia. The results found for analysed samples collected in 2005 and 2009 are summarised in Table 1. There are no literature dates for ^{129}I and ^{127}I concentrations in blue mussel. Values found in analysed seawater and sediment samples are in agreement with values found in literature for areas that are not under the influence of direct liquid discharges of ^{129}I from nuclear fuel reprocessing plants. ^{129}I and ^{127}I concentrations found in analysed alga collected in 2005 and 2009 (Table 1) are in the same range. The ratio of $^{129}I/^{127}I$ found for alga *Fucus virsoides* is up to 10^{-9}, which is one order of magnitude higher than along the coast of China, up to two orders of magnitude lower than in the Baltic Sea, which is influenced by direct liquid discharges from La Hague and Sellafield, and up to four orders of magnitude lower than in the vicinity of the La Hague reprocessing plant.

Tab. 1. Range of ^{129}I and ^{127}I in marine environment of North Adriatic Sea

Sample	Number of samples	Year of sampling	Range	
			^{127}I (μg g^{-1} dry weight)	^{129}I (10^{-9} μg g^{-1} dry weight)
Seawater	6	2009	0.052 – 0.070	1.3 – 55.4
Alga (*Fucus virsoides*)	3	2009	267 – 470	334 – 452
	5	2005[a]	371 – 448	362 – 471
Blue mussel (*Mytilus galloprovincialis*)	3	2009	9.9 – 14.6	104 – 127
Sediment	4	2005	59.3 – 76.8	72 – 256

[a] published in 2008 [4]

The data of this study represent a survey of ^{129}I in the marine environment of Slovenia. The most likely source of ^{129}I are nuclear fuel reprocessing plants in La Hague and Sellafield, which are known to be the major sources of ^{129}I in the environment of North Europe. ^{129}I is transferred to the atmosphere and washed out to the marine environment of Slovenia by precipitation, so it is of atmospheric-precipitation origin.

References

1 - Muramatsu Y., Yoshida S., Fehn U., Amachi S. and Ohmomo Y., 2004. Studies with natural and anthropogenic iodine isotopes: iodine distribution and cycling in the global environment. *J. Environ. Radioact.*, 74: 221-232.
2 - Osterc A., Jacimovic R. and Stibilj V., 2007. Development of a method for ^{129}I determination using radiochemical neutron activation analysis. *Acta Chim. Slov.*, 54: 273-283.
3 - Osterc A. and Stibilj V., 2005. Measurement uncertainty of iodine determination in radiochemical neutron activation analysis. *Accredit. qual. assur.*,10:235-240.
4 - Osterc A. and Stibilj V., 2008. ^{127}I and $^{129}I/^{127}I$ isotopic ratio in marine alga *Fucus virsoides* from the North Adriatic Sea. *J. environ. radioact.*, 99: 757-765.

THE DISTRIBUTION OF ZN IN SEAWATER AND SEDIMENTS OF A COASTAL MARINE AREA AFFECTED BY INDUSTRIAL ACTIVITIES (NW SARONIKOS GULF)

Vasiliki Paraskevopoulou [1], Emmanouel Dassenakis [1]*, Styliani Triantafyllaki [1] and Nikos Giannikopoulos [1]
[1] Laboratory of Environmental Chemistry, Dept. of Chemistry, University of Athens - edasenak@chem.uoa.gr

Abstract
An oceanographic study of the coast of the North West Saronikos Gulf was carried out in the years 2006 and 2007. The area is affected by industrial and urban activities. Seawater and sediment samples were collected and various trace metals were determined. The present paper presents the results on the distributions and behaviour of Zn, which a metal of significant environmental importance, in this coastal marine environment.
Keywords: Aegean Sea, Coastal Waters, Zinc

INTRODUCTION
North West Saronikos Gulf is located 80 km west of Athens. This marine area is affected by industrial activities (oil refinery, cable manufacturer, soya mills, sulphur and fertilizers manufacturing), as well as touristic activity in the towns of Agioi Theodoroi and Isthmia. Furthermore the coastal zone of North West Saronikos is located on the Sousaki volcanic region therefore this area is characterized by a unique geological setting.

MATERIALS AND METHODS
The area was studied extensively from January 2006 to December 2007. There were 8 seasonal samplings in 9 coastal stations (MOT 1-MOT 9), in 7 off shore stations with depths ranging from 20 to 100m (MOT 10-16) and one off-shore station in the Megara Basin (UN6) with a depth of 200m. Dissolved and particulate Zn determinations were carried out using Chelex 100 pre-concentration and nitric acid digestion respectively. Total Zn in sediments was extracted with strong acids (including HF) digestion [1]. The non lattice fraction of Zn was extracted with 0,5M HCl and with the BCR protocol [2]. All extracts from the above procedures were measured with Flame Atomic Absorption Spectrometry.

RESULTS AND DISCUSSION
The water column in both near-shore and off-shore stations was fully oxygenated in all seasons due to adequate water circulation. The theromocline started forming in June and was fully developed between 30 and 40m depth in August and September. The water column below 150m (UN6) has been isolated since 1992, therefore almost anoxic conditions prevail. Dissolved Zn ranged from 0,41 to 39,2 μg/L, while particulate Zn ranged from 0,11 to 4,1 μg/L. The dissolved Zn fraction comprised of more than 75% of the total concentration in all samplings. The average total Zn concentrations of coastal and off-shore stations were 2,7 and 5,1 μg/L respectively and differed statistically (independent samples t-test). The off-shore stations exhibited a wider range of concentrations and some extreme values. The concentrations of total Zn below the depth of 20m were statistically higher than the corresponding concentrations at the surface and 20m. This was also depicted in the vertical profiles of total Zn in almost all sampling stations. The levels of total Zn in the off-shore stations of the study area were similar to the values of offshore East and South Saronikos Gulf but lower than the more polluted Elefsis Gulf which is characterised by more intensive industrial activity [3].
The total Zn concentrations in sediments ranged from 27,7 to 120 mg/kg.

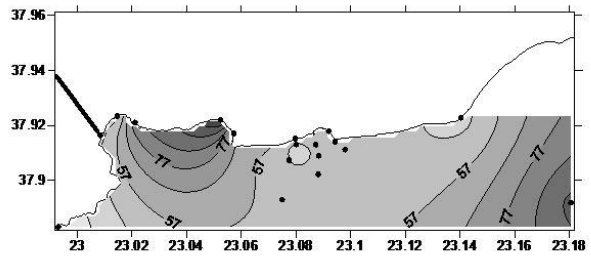


Fig. 1. Figure 1 Surface distribution of total Zn (mg/kg) in the sediments of the study area

The highest concentrations were determined in stations MOT5 (near a small shipyard) and UN6 (200m depth). The non lattice held (BCR1-3) concentrations of Zn ranged from 8,6 to 36,6 mg/kg and represented 17-53% of the total content. The highest percentages were determined near the main industries (stations MOT 2, 3 and 4). The non lattice held Zn was mostly found associated with Fe and Mn oxides (BCR2). The stations MOT5 and UN6 exhibited Sediment Enrichment Factors higher than 2 therefore the total Zn concentrations in these sediments could be attributed to anthropogenic pollution. The vertical distribution of total and non lattice held Zn in a small sediment core (10cm) of station UN6 also shows a marked increase in the surface layer which could be attributed to anthropogenic influence.

CONCLUSIONS
The study area of North West Saronikos Gulf is not a conventional hot spot due to increased depth and adequate water circulation and dilution. The levels of Zn in seawater and sediments were similar to other Greek marine areas and much lower than the most polluted part of the Gulf of Elefsis and East Saronikos. The significant pollution sources mentioned above and the neighbouring of populated and touristic towns suggest frequent monitoring of selected points to ensure that pollution levels remain fairly constant.

ACKNOWLEDGMENTS: This paper is part of the 03ED186 research project (PENED), co-financed by E.U.-European Social Fund (75%) and the Greek Ministry of Development-GSRT (25%).

References
1 - ISO 14869-1:2000. Soil quality- Dissolution for the determination of total element content-Part 1: Dissolution with hydrofluoric and perchloric acids.
2 - European Commission, Rauret G, Lopez-Sanchez J.F., Sahuquillo A., Muntau H., Quevaviller Ph., 2000. BCR information. Indicative values for extractable contents (mass fractions) of Cd, Cr, Cu, Ni, Pb and Zn in sediment (CRM 601) following the modified BCR-sequential extraction (three-step) procedure'', EUR 19502 EN.
3 - Scoullos M., Sakellari A., Giannopoulou K., Paraskevopoulou V., Dassenakis M., 2007. Dissolved and particulate trace metal levels in Saronikos Gulf, Greece, in 2004. The role of the wastewater treatment plant of Psitalia. *Desalination* 210: 98-109.

DISSOLVED OXYGEN AND NUTRIENT DISTRIBUTION IN NORTH AEGEAN SEA

Alexandra Pavlidou [1]*, Evagelia Krassakopoulou [1] and Ekaterini Souvermezoglou [1]
[1] HELLENIC CENTER FOR MARINE RESEARCH (HCMR) - aleka@ath.hcmr.gr

Abstract

In this work we present Dissolved Oxygen (DO) and inorganic nutrient (nitrate, nitrite, phosphate and silicate) distribution in the North Aegean Sea during April 2008 under the influence of different water masses. The Black Sea Water outcoming from the Dardanelles strait is not enriched in dissolved inorganic nutrients. On the contrary, the North Aegean Deep Waters carry higher concentrations of nutrients. According to DO data, formation of deep waters occurred at station NA2, but not at station NA7.

Keywords: Aegean Sea, Nutrients, Oxygen

Introduction

The brackish, relatively cold and mestrophic waters exported from the Black Sea to the Marmara upper layer, reach the saline, oligotrophic waters of the Aegean Sea via the Dardanelles surface outflow. Thus, the Black Sea waters (BSW) are expected to contribute to the nutrient balances in the North Aegean Sea [1,2]. On the other hand, the salty Aegean waters enter the Marmara deep basin. The bottom layers of the North Aegean Sea contain one of the denser waters of the world (σ_θ > 29.5 kg m^{-3}), making it one of the principal dense water formation regions of the Mediterranean [3]. Below the surface layer there is a warm and highly saline water layer originating from the South Aegean and the Levantine, Levantine Intermediate Water (LIW), extending down to 350-400m depth [4,5]. The present work reports the Dissolved Oxygen (DO) and nutrient characteristics in the North Aegean Sea under the influence of the aforementioned different water masses.

Results and discussion

During the first week of April 2008, sampling was performed at 10 stations; among them, 4 stations were located close to the Dardanelles Strait, 2 northeastern of Lemnos Island and 3 northwestern of Samothraki Island (Fig.1).

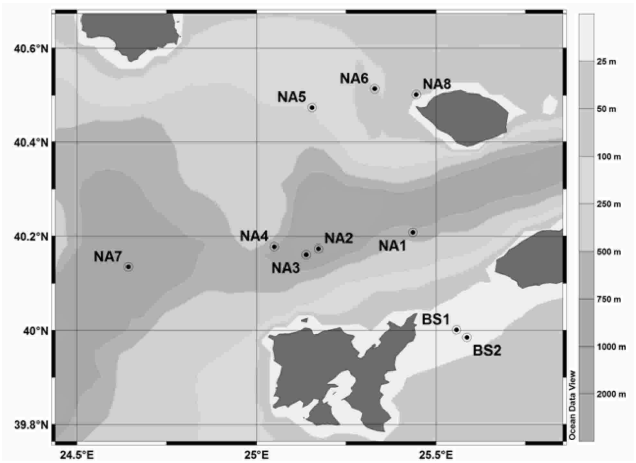


Fig. 1. Bathymetric map of the study area and sampling stations

Mean concentrations of our data are presented in Table I. The DO vertical distribution seem to follow the salinity differences, showing maximum at the surface less saline light waters at the stations located near to the Dardanelles strait which indicate biological production. The significant decrease of DO which was observed at the bottom waters of station NA7 suggest a rather long stagnation period where bottom water formation has not occurred [6]. The BSW outcoming from the Dardanelles strait does not seem to be enriched in dissolved inorganic nutrients, but in organic nutrients [1]. Low inorganic nutrient concentrations have also been reported in other studies in the area, probably because of their exploitation by phytoplankton [7]. On the contrary, the North Aegean Deep Waters (bellow 400m depth, σ_θ> 29.35) carry higher concentrations of nutrients.

Tab. 1. Mean concentrations of DO and nutrients in North Aegean Sea

	Stations close to Dardanelles (max depth =1000m)	*Northeastern of Lemnos Isl. (max depth =40m)*	*Northwestern of Samothraki Isl. (max depth =250m)*
σ_θ < 28.8			
DO (μM)	260 ± 8.45	260 ± 1.36	257 ± 7.28
DIN (μM)	0.19 ± 0.14	0.31 ± 0.13	1.42 ± 0.22
Phosphate (nM)	5.01 ± 0.91	2.13 ± 0.41	10.1 ± 8.25
Silicate (μM)	1.54 ± 0.51	2.00 ± 0.60	1.20 ± 0.23
DIN:P	37	~90	22.2
	n=12	*n=3*	*n=15*
28.8 <σ_θ < 29.35			
DO (μM)	236 ± 5.16	248 ± 3.73	237 ± 8.18
DIN (μM)	1.05 ± 0.42	0.33 ± 0.22	1.56 ± 0.36
Phosphate (nM)	47.8 ± 24.3	4.05 ± 2.70	77.4 ± 15.1
Silicate (μM)	1.34 ± 0.43	1.65 ± 0.54	1.50 ± 0.23
DIN:P	29.6	84	20.2
	n=20	*n=7*	*n=5*
σ_θ > 29.35			
DO (μM)	225 ± 3.82		
DIN (μM)	1.70 ± 0.39		
Phosphate (nM)	59.0 ± 10.9		
Silicate (μM)	2.21 ± 0.79		
DIN:P	*26*		
	n=6		

At the deep layer of station NA2 nutrients found to be lower than the ones measured at the deep waters of station NA7. More specifically, a decrease of 1.75 μM for inorganic nitrogen, 117.9 nM for phosphate and 3.81 μM for silicate is observed, while the accompanied increase of DO is 17 μM. According to our results it is obvious that formation of deep waters occurred at station NA2, but not at station NA7.

Acknowledgements: The present study was conducted within the framework of the European IP Project FP6 - *Sesame EC*

References

1 - Polat, C. and Tugrul, S. 1996. Chemical exchange between the Mediterannean and the Black Sea via the Turkish straits. *In*: Frederic Briand (ed), CIESM Science Series 2: Dynamics of the Mediterranean Straits and Channels, Bulletin de Institute Oceanographique, N° special 17, Monaco, pp. 167-186.

2 - Siokou-Frangou, I., Zervoudaki, S., Christou, E., Zervakis, V., Georgopoulos, D., 2009. Variability of mesozooplankton spatial distribution in the North Aegean Sea, as influenced by the Black Sea Waters. *Journal of Marine Systems*, in press.

3 - Zervakis, V. and Georgopoulos, D. 2002. Hydrology and circulation in the North Aegean (Eastern Mediterranean) throughout 1997-1998. *Mediterranean Marine Science*, 3(1): 7-21.

4 - Theocharis, A., Balopoulos, E., Kioroglou, S., Kontoyiannis, H., Iona, A., 1999. A synthesis of the circulation and hydrography of the South Aegean Sea and the straits of the Cretan Arc. *Progress in Oceanogr*aphy 44: 469-509

5 - Zervakis, V., Georgopoulos, D., Drakopoulos, P.G., 2000. The role of the North Aegean Sea in the triggering the recent Eastern Mediterranean climatic changes. Journal of Geophysical Research, 105 (C11): 26103-26116

6 - Zervakis, V., Krasakopoulou, E., Georgopoulos, D., Souvermazoglou, E., 2003. Vertical diffusion and oxygen consumption during stagnation periods in the deep North Aegean. *Deep-Sea Research I*, 50: 53-71

7 - Siokou-Frangou I., Bianchi, M., Christaki, U., Christou, E., Giannakourou, A., Gotsis, O., Ignatiades, L., Pagou, K., Pitta, P., Psara, S., Souvermezoglou, E., Van Wambeke, F., Zervakis, V. 2002. Carbon flow in the planktonic food web along a gradient of oligotrophy in the Aegean Sea (Mediterranean Sea**).** *Journal of Marine Systems*, 33-34: 335-353.

HEAVY METAL CONTAMINATION IN CANDARLI BAY SEDIMENT: EASTERN AEGEAN SEA

Idil Pazi [1]*, Filiz Kucuksezgin [1] and Dogan Yasar [1]
[1] Dokuz Eylul University Institute of Marine Sciences & Technology - idil.erden@deu.edu.tr

Abstract
The accumulation of trace metals in sediments may cause serious environmental problems in the aquatic system. 8 sediment samples were collected using box corer in the Candarli Gulf in 2009 for a study on trace metal pollution. The concentrations of Hg, Pb, Cr, Zn and Al in the surface sediment layers were generally elevated when compared with the sub-surface layers. The metal levels were evaluated according to the enrichment factor analysis. The results revealed significant anthropogenic pollution of Hg and Pb in the surficial sediments of Candarli Gulf.
Keywords: Aegean Sea, Metals, Sediments

Introduction
Heavy metals are deemed serious pollutants because of toxicity, persistence and non-degradability in the environment [1, 2, 3]. Heavy metal contamination in sediment, soil and groundwater is one of the largest threats to environmental and human health [4]. Therefore, heavy metal contamination is still an environmental problem today in both developing and developed countries throughout the world. Few published data are present on metal concentrations from Aliaga Bay [5], but no data are available on metal levels in Candarli Gulf. The aim of this study is to comparatively evaluate Hg, Pb, Cr, Zn and Al concentrations in sediment, collected from different sites of Candarli Gulf.

Materials and Methods
In the framework of MEDPOL Phase IV Project, sediment samples were collected from 8 stations in Candarli Gulf using box corer to detect heavy-metal concentrations by *R/V K. Piri Reis* (Institute of Marine Sciences and Technology). At each station surface and subsurface sediments (15-20 cm below the surface) were collected. Subsurface sediments were used as background levels for each element at all stations. Concentrations of Hg, Pb, Cr, Zn and Al were determined in the digested phase using ICP-ES/ICP-MS (ACME Analytical Labs, Vancouver, BC) in sediment samples.

Results and Discussion
Trace metal concentrations in sediments from the Station 6 (Sta. 6) are consistently higher than those from the other locations. The station near the PETKIM Complex has the highest values for Hg (6.3 mg/kg) Pb (138 mg/kg), and Zn (358 mg/kg). Cr level was measured as 44.6 mg/kg at Sta.6. This area is under the influence of the wastewaters and water-runoff from that industrial activity (rich in heavy metals). EFs present the identification and quantification of metal enrichment. Major population and industry in Candarli Gulf are located in Aliaga town. The relatively high trace metal enrichments in this region are therefore likely to originate from past and present day inputs. EF values tended to the greatest in Sta. 6. Enrichment factor of Cr are generally less than 1.5 (except Sta.6) suggesting that Cr contamination is not a problem at present. However, Candarli Gulf is severally contaminated by Hg, Pb and Zn as reflected by the enrichment factor values of these metals are all greater than 1.5. Enrichment factor results further indicated that these contaminants came from human impacts.

Conclusion
The metals contamination in sediment of studied locations may of anthropogenic origin with the exception of some local anomalies. When compared with the elemental background compositions, surface sediments were observed to be not contaminated with Cr. However, other elements, Zn, Pb and Hg with greater anthropogenic inputs, were observed to be enriched in the gulf sediment samples.

References
1 - Klavins M., Briede A., Rodinov V., Kokorite I., Parele E. and Klavina I., 2000. Heavy metals in rivers of Latvia. *The Science of the Total Environment*, 262: 175-183.
2 - Tam N.F.Y. and Wong Y.S., 2000. Spatial variation of heavy metals in surface sediments of Hong Kong Mangrove Swamps. *Environmental Pollution*, 110: 195-205.
3 - Yuan C., Shi J., He B., Liu J., Liang L. and Jiang G., 2004. Speciation of heavy metals in marine sediments from the East China Sea by ICP-MS with sequential extraction. *Environment International*, 30: 769-783.
4 - Salomons W. and Förstner U., 1984. Metals in the Hydrocycle. Springer Verlag, Berlin.
5 - Sponza D. and Karaoglu N., 2002. Environmental geochemistry and pollution studies of Aliaga metal industry district. *Environment International*, 27: 541-553.

MODELING STABLE ISOTOPE RATIOS IN NEAR SURFACE WATER VAPOR IN THE MEDITERRANEAN: AN EVALUATION OF THE CRAIG-GORDON MODEL

Stephan Pfahl [1]* and Heini Wernli [1]
[1] Institute for Atmospheric and Climate Science, ETH Zurich, 8092 Zurich, Switzerland - stephan.pfahl@env.ethz.ch

Abstract
Stable isotope ratios in water vapor at Rehovot (Israel) are modeled with the help of the Craig-Gordon model, applied in a Lagrangian setup using backward trajectories. The comparison of the simulation results with measurements at Rehovot allows to infer about uncertain model parameters as the non-equilibrium fractionation factor. A new parameterization for this fractionation factor is suggested and applied in a first case study with a mesoscale dynamical model.
Keywords: Water Transport, Air-Sea Interactions

Introduction
Stable water isotopes are widely used as diagnostic tools for investigating the global water cycle. An important step in this cycle is the evaporation of water from the ocean. The concurrence of equilibrium and non-equilibrium processes complicates a quantitative description and parameterization of isotope fractionation during evaporation. A linear resistance model, as introduced by Craig and Gordon [1], is commonly applied for this parameterization. In such a model, the isotope ratio in the evaporation flux can be expressed as follows:

$$R_E = k \cdot \frac{\alpha R_L - h R_A}{1 - h} \quad (1),$$

where R_L and R_A give the isotope ratios in the ocean and in atmospheric vapor, respectively; h denotes the relative humidity of the atmosphere, defined with respect to saturation at the sea surface, α is the equilibrium fractionation factor between vapor and liquid at the surface, and finally k denotes a non-equilibrium (diffusive) fractionation factor. This non-equilibrium fractionation factor is usually expressed according to [2], but its formulation is hardly constrained by atmospheric observations.

Methodology
This study addresses this issue by combining a recently developed Lagrangian moisture source analysis [3] with a Craig-Gordon fractionation parameterization (equation 1) in order to model isotope ratios in near-surface water vapor [4]. This technique is applied to 45 days of isotope measurements in water vapor at Rehovot (Israel) during the years 2001 to 2006 [5]. Different parameterizations for the non-equilibrium fractionation factor are tested in this setup. Finally, the mesocsale dynamical COSMO model [6] is equipped with the most successful parameterization and applied for simulating the spatial distribution of deuterium excess in water vapor close to the surface.

Results and Discussion
A comparison of the simulated deuterium excess from the Lagrangian approach with the measurements shows that a much better agreement can be achieved using a wind speed independent formulation of k (correlation coefficient r=0.80, RMSE=4.6 permil) instead of the classical parameterization by Merlivat and Jouzel [2] (r=0.53, RMSE=10.7 permil). The numerical values of k that lead to the best agreement of simulated and observed deuterium excess are k_{18O} =0.9925 and k_{2H}=0.9961. These values are consistent with data from other studies. In future research, it should be tested if the empirically derived, wind speed independent parameterization also leads to an improvement of the performance of other models, including GCMs, in modeling deuterium excess. A first case study with the COSMO model verifies that the model is suitable for simulating spatial distributions of isotopes in water vapor in an event-based manner. The simulated deuterium excess compares well with results from a Lagrangian diagnostic [4], confirming the usefulness of the new parameterization.

References
1 - Craig, H., and L. I. Gordon, 1965. Deuterium and oxygen 18 variations in the ocean and the marine atmosphere. *In* E. Tongiorgi (ed.), Stable Isotopes in Oceanographic Studies and Paleotemperatures, pp. 9– 130, Lab. Geol. Nucl., Pisa, Italy.
2 - Merlivat, L., and J. Jouzel. 1979. Global climatic interpretation of the deuterium-oxygen 18 relationship for precipitation. *J. Geophys. Res.,*84, 5029– 5033.
3 - Pfahl, S., and H. Wernli, 2008. Air parcel trajectory analysis of stable isotopes in water vapor in the eastern Mediterranean. *J. Geophys. Res.*, 113, D20104.
4 - Pfahl S., H. Wernli, 2009. Lagrangian simulations of stable isotopes in water vapor: An evaluation of nonequilibrium fractionation in the Craig-Gordon model. *J. Geophys. Res.*, 114, D20108.
5 - Angert, A., J.-E. Lee, and D. Yakir, 2008. Seasonal variations in the isotopic composition of near surface water vapor in the Eastern-Mediterranean. *Tellus B*, 60, 674– 684.
6 - Steppeler, J., G. Doms, U. Schättler, H. W. Bitzer, A. Gassmann, U. Damrath, and G. Gregoric, 2003. Meso-gamma scale forecast using the nonhydrostatic model LM. *Meteorol. Atmos. Phys.,* 82, 75-96.

CHARACTERIZATION OF THE MEDITERRANEAN SEA MUSSEL REFERENCE MATERIAL (IAEA-437)

M. K. Pham [1]*, M. Betti [1], P. P Povinec [2], A. M. Rodriguez Y Baena [3] and H. Thebault [4]
[1] IAEA- Marine Environmental Laboratories - m.pham@iaea.org
[2] Comenius University, Faculty of Mathematics, Physics and Informatics, Mlynska dolina F-1, SK-84248 Bratislava, Slovakia
[3] CIESM, 16, Bld de Suisse, MC-98000 Monaco
[4] Institut de Radioprotection et de Sureté Nucléaire (IRSN0, LERCM, Centre Ifremer, BP 330, F-83507 La Seyne sur Mer, France

Abstract

The characterization of a new Reference Material (RM) for radionuclides in mussel (*Mytilus galloprovincialis*) from the Mediterranean Sea (IAEA-437) is described and the results of the certification process are presented. Four radionuclides (^{40}K, ^{234}U, ^{238}U, and $^{239+240}$Pu) have been certified, and information values on massic activities with 95% confidence intervals are given for nine other radionuclides (^{137}Cs, ^{210}Pb(^{210}Po), ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{232}Th, ^{235}U, and ^{241}Am). The IAEA-437 RM is intended to be used for quality assurance/quality control of radionuclide analyses of mussel samples using radiometric and mass spectrometry techniques (ICP-MS, AMS), for the development and the validation of analytical methods, for the development of reference methods and for training purposes.

Keywords: Radionuclides, Mediterranean Ridge, Pollution, Instruments And Techniques, Monitoring

Introduction

In collaboration with CIESM, an inter-laboratory comparison exercise using Mediterranean Mussel Reference Material was previously organised to test the performance of laboratories in analytical quality control [1-2]. More data from expert laboratories have been obtained during 2008-2009 allowing to assign the true values and the uncertainties of different radionuclides in this specific matrix of marine sample, and in consequence to permit to issue a new Certified Reference Material for Marine Environmental Study.

Experimental

The work was performed on a mussel tissue sample, which is commonly found and consumed seafood, and is widely used as bio-indicators in marine pollution studies. They were collected from the Mediterranean Sea in the framework of the CIESM (Commission Internationale pour l'Exploitation Scientifique de la Mer Mediterranée) Mediterranean Mussel Watch Program. About 1080 kg of mussel sample (*Mytilus galloprovincialis* species) was collected in Anse de Carteau, Port Saint Louis du Rhône (43°20'S, 5°10'E), France, by the Institut de Radioprotection et de Sûreté Nucléaire (IRSN, France) in June 2003. More detail of description of the material could be found in [1-2]. Of 34 laboratories received the sample, a total of 24 sets of results were received from participants and included in the evaluation report of the interlaboratory comparison exercise [2]. Because of very low-levels of radionuclide activities in the sample, 16 more samples were sent to 5 members of CELLAR (Collaboration of European Low-Level Underground Laboratories) and to 11 expert laboratories in 2007. High quality data from the interlaboratory comparison exercise, and additional data from the CELLAR and expert laboratories were included in the certification process, results of which are reported in the present paper.

Results and discussion

Homogeneity tests :The homogeneity of the sample was checked by measuring the activities of ^{40}K, ^{137}Cs, ^{235}U, ^{238}U, $^{239+240}$Pu and ^{241}Am on 5-17 bottles taken at random. Gamma-spectrometric measurements were performed on 100 g of mussel. The activity concentrations of ^{235}U, ^{238}U, $^{239+240}$Pu and ^{241}Am were determined by ICP-MS and alpha spectrometry on 0.5 to 100 g of mussel sample, respectively. Homogeneity was determined using one-way analysis of variance. The coefficient of variation was below 15% for gamma, alpha-spectrometrically determined radionuclides (with activity concentration less than 1 Bq kg^{-1}). The "between samples" variances showed no significant differences from the "within sample" variances for all analysed radionuclides. The material was thus considered sufficiently homogeneous for the tested radionuclides at the range of weights used.

Certification process: The certification process was carried out following the ISO Guide 35 [3] using the most precise and accurate data from interlaboratory comparison exercise and additional data from CELLAR and expert laboratories. For data sets comprising 5 or more accepted laboratory means, the median activities for the sets of individual data – after rejection of outliers – were chosen as the best estimations of the property values [4]. Evidence on metrological traceability to the SI units was provided by all laboratories in their reports.

Only 4 radionuclides ^{40}K, ^{234}U, ^{238}U and $^{239+240}$Pu were certified in the certification process. The mean, median values with 95 % confidence intervals, the number of accepted means which were used to calculate the certified activities are given in Table 1. Information values are given for 9 radionuclides: ^{137}Cs, ^{210}Pb(^{210}Po), ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{232}Th, ^{235}U and ^{241}Am. The mean, median values with 95 % confidence intervals, the number of accepted means which were used to calculate the activities are given in Table 2.

Tab. 1. Certified mass activities in IAEA-437 Mussel from the Mediterranean Sea(Reference date: 1 November 2003)

Radionuclide	Mean ± Std. Dev. (Bq kg^{-1}dw)	Median (Bq kg^{-1}dw)	95% Confidence Interval (Bq kg^{-1}dw)	N^a	N^b
^{40}K	373 ± 20	373	360 – 380	21	91
^{234}U	2.3 ± 0.1	2.3	2.2 – 2.4	9	42
^{238}U	1.86 ± 0.09	1.87	1.80 – 1.92	14	57
$^{239+240}$Pu	0.0078 ± 0.0006	0.0076	0.0071 – 0.0082	11	45

N^a: Number of accepted laboratory means which were used to calculate the certified mass activities and the corresponding confidence intervals. N^b: Total number of assays.

Tab. 2. Information mass activities in IAEA-437 Mussel from the Mediterranean Sea (Reference date: 1 November 2003)

Radionuclide	Mean ± Std. Dev. (Bq kg^{-1}dw)	Median (Bq kg^{-1}dw)	95% Confidence Interval (Bq kg^{-1}dw)	N^a	N^b
^{137}Cs	0.16 ± 0.06	0.14	0.11 – 0.23	9	67
^{210}Po(^{210}Pb)*	4.6 ± 1.1	4.2	4.0 – 5.4	26	71
^{226}Ra	0.26 ± 0.09	0.27	0.21 -0.31	9	48
^{228}Ra	1.44 ± 0.29	1.48	1.00 – 1.80	7	24
^{228}Th	0.79 ± 0.17	0.79	0.71 – 0.96	9	58
^{230}Th	0.21 ± 0.09	0.16	0.15 – 0.40	6	21
^{232}Th	0.13 ± 0.05	0.11	0.09 – 0.16	8	30
^{235}U	0.09 ± 0.02	0.09	0.07 – 0.11	9	34
^{241}Am#	0.019± 0.010	0.020	0.008 – 0.034	5	39

N^a: Number of accepted laboratory means which were used to calculate the information mass activities and the corresponding confidence intervals. N^b: Total number of assays.
* Two corrections for ^{210}Po and ^{210}Pb determination should be applied during a storage time: (i) a correction for ^{210}Pb decay (the half-life 22.2y) and (ii) a correction for in-growth of ^{210}Pb from ^{226}Ra.
# Values should be corrected for in-growth from ^{241}Pu.

Acknowledgments

The authors are indebted to their numerous colleagues who took part in the analytical works. Special acknowledgement is given to the Professor Frederic Briand, Director General of CIESM, for financial support provided for the Mediterranean Mussel Watch Program and to the Institut de Radioprotection et de Sûreté Nucléaire (IRSN, France) for providing the mussel sample. The IAEA is grateful for the support provided to its Marine Environment Laboratories by the Government of the Principality of Monaco.

References

1 - Pham, M.K., Sanchez-Cabeza, J.A., Osvath, O. and Thébaut, H., 2007. Intercomparison exercise for radionuclides in Mediterranean Mussel (IAEA-437). Rapp. Comm. Int. Mer Médit., 38.

2 - Pham, M.K. and Sanchez-Cabeza, J.A., 2007. "Report on the worldwide intercomparison exercise IAEA-437: Radionuclides in Mediterranean Mussel", IAEA/AL/173, IAEA/MEL/79. IAEA, Monaco (37pp).

3 - International Standard Organization (ISO), Guide 35 "Certification of Reference Materials – General and Statistical Principles" *ISO*, Geneva., 2006.

4 - Sanchez-Cabeza, J.A., Pham, M.K, Povinec P.P., 2008. IAEA programme on the quality of marine radioactivity data. *J. Environ. Rad*. 99, 1680-1686.

DETERMINATION OF POLYMERIC ORGANIC MATERIAL CONTAINING "N-CATALYST" IN SEAWATER BY CONSTANT CURRENT CHRONOPOTENTIOMETRIC STRIPPING ANALYSIS

Marta Plavsic [1]*, Sladjana Strmecki [1] and Bozena Cosovic [1]
[1] Ruder Boskovic Institute, Bijenicka c. 54, 10000 Zagreb, Croatia - plavsic@irb.hr

Abstract
Catalytic properties and surface activity of nitrogen containing polymeric organic material (N-POM) were analyzed by constant current chronopotentiometric stripping analysis (CPSA) in seawater. CPSA proved to be a suitable method for determination of low concentrations of N-POM in seawater by measuring its "presodium" catalytic peak H. A protein human serum albumin (HSA) (15 % of N) was used as a model compound and the concentration of N-POM from natural seawater samples was expressed in HSA concentration equivalents.
Keywords: Electrochemistry, Adriatic Sea, Organic Matter

Introduction
Chronopotentiometric stripping analysis (CPSA) is an electrochemical technique in which preconcentrating step proceeds at negative potentials where amalgam is formed, followed by stripping step in which constant current is applied to strip the accumulated material. CPSA peak which appears is not due to the faradaic but to the catalytic reduction of hydrogen. That peak appears more positively on potential scale than usual hydrogen wave, preceeding the reduction of sodium ions. It is named peak "H" or catalytic hydrogen or "presodium" wave and a key organic molecule is called a "presodium" catalyst [1] already reported about CPS detection of peak H catalyzed by sulphur atoms in polysaccharides excreted from plankton cultures. A more negative peak H, at -1.7 V, was observed as well and a connection with the presence of polymeric organic matter containing N catalytic atoms was supposed [3]. Seawater samples were collected in the Northern Adriatic in 4 seasons: June and October 2008 and in January and March 2009, at surface (0.5 m depth) and bottom (~31 m depth), as well in some other areas in the Adriatic.

Results and Discussion
From peak H height measured in the seawater samples we could not characterize N-POM on molecular basis, as for that some specific separation techniques and characterization methods should be included. Macroaggregates found in the Northern Adriatic are characterized by high C/N ratio due to their low protein content having carbohydrates as a major component. Surface samples were richer in N- POM than bottom samples in all seasons. We calculated N-POM/SAS and N-POM/DOC and concluded that N-POM made a minor part of SAS and DOC in seawater samples comprising a few percent.

Acknowledgement: The financial support of the Croatian Ministry of Science, Education and Sport for the project no. 098-098-2934-2717 is gratefully acknowledged

References
1 - Mader, P., Vesela, V., Dorcak, V., Heyrovsky, M., 2001. The 'presodium' hydrogen evolution at the dropping mercury electrode catalyzed by simple cysteine peptides. Collect Czech Chem Commun 66: 397–410.
2 - Ciglenecki,I., Plavšic, M., Vojvodic, V., Cosovic, B., Pepi, M., Baldi, F., 2003, Evidence of mucopolysaccharide transformation by sulfide: comparisons between an enriched mixed benthic diatom culture and natural mucilage,*Mar. Ecol. Prog. Ser, 263*, 17-27.
3 - Strmecki, S., Plavšic, M., Cosovic. B.,2009. Constant current chronopotentiometric stripping analysis of "N-catalyst" in sodium chloride solution and seawater, *Electroanalysis*, in press.

OLIGOTROPHICATION OF THE NORTHERN ADRIATIC, TRUE OR FALSE?

Robert Precali [1]*, Tamara Djakovac [1] and Danilo Degobbis [1]
[1] Center for Marine Research, Ruder Boškovic Institute - precali@cim.irb.hr

Abstract

From 2003 to 2008 NA experienced a reduced input of freshwater and nutrients. In the second part of 2008, after five years, the Po River flow was higher than its average and in the whole NA the "oligotrophication scenario" (reduced trophic level) shifted to usual behaviour. The response to the change was immediate, indicating the fragility of the pelagic ecosystem.

Keywords: Chlorophyll-a, Nutrients

Introduction

The northern Adriatic (NA) is mainly under the influence of the Po River (70 % of the inflow), one of the largest Mediterranean rivers. The last decade is characterized by a strong decrease in Chl *a* concentration in the whole NA and confirmed all over the basin (-0.11 mg m^{-3} a^{-1}) from satellite derived information [1]. A decrease in freshwater inflow and input of nutrients resulted in a reduced availability (greater limitation) of phosphorous (P), and accumulation of total inorganic nitrogen (TIN) in the ecosystem [2]. In this work we are trying to understand how fragile such an ecosystem is when freshwater input increases again.

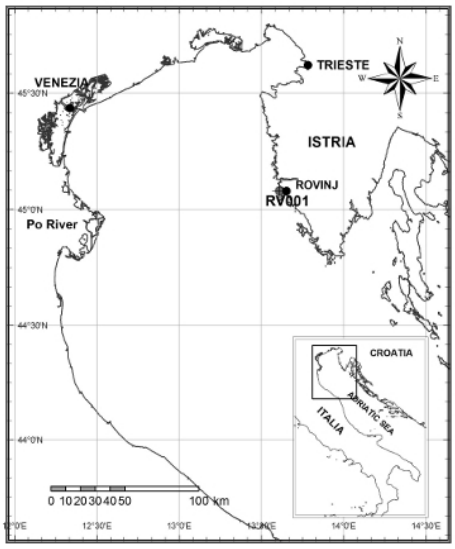


Fig. 1. Northern Adriatic map and station locations

Methods

Sampling, parameters determination and calculation

Water samples for nutrients (amonium, nitrite, nitrate, orthosilicate and orthophosphate) and chlorophyll *a* concentration measurements were collected on a monthly scale from Jan 2007 to Dec 2008 at five oceanographic depths at station RV001 near Rovinj (Croatia, Fig. 1). Parameters were determined by standard oceanographic methods described in previous authors' publications. To understand the recent variability only residuals, after the removal of model values, are presented.

Model

Data collected from 1972-2002 on a monthly base were used to build an annual model. On annual scale through the data a Fourier smoother (with retained three harmonics) was passed.

Results and discussion

Station RV001 in the Istrian coastal area well represents the main processes in the open NA waters mainly because the local ones are not pronounced [2]. In the period 2007-2008 Chl *a* and orthophosphate (PO_4) concentrations were systematically lower than average confirming the overall trend in the wider area (Fig.2, [2]). On the contrary, TIN concentrations were higher than average over a great part of the investigated period, showing the coupling of greater P limitation and accumulation of TIN in the ecosystem. In 2008, more pronounced in the second part of the year (Fig. 2), the freshwater inflow increased and resulted in TIN consumption as more P was available in the ecosystem. The increase of biomass (Chl *a*) was not observed probably due to a higher efficiency of nutrients use by the phytoplankton community.

The results show that the ecosystem rapidly responds to the input of fresh nutrients and that is well adapted to such a type of *stimuli*. Oligotrophication of the area is than only a measure to nutrient inputs, and controlled by the effectiveness of anthropogenic mitigation measures and climatic oscillations.

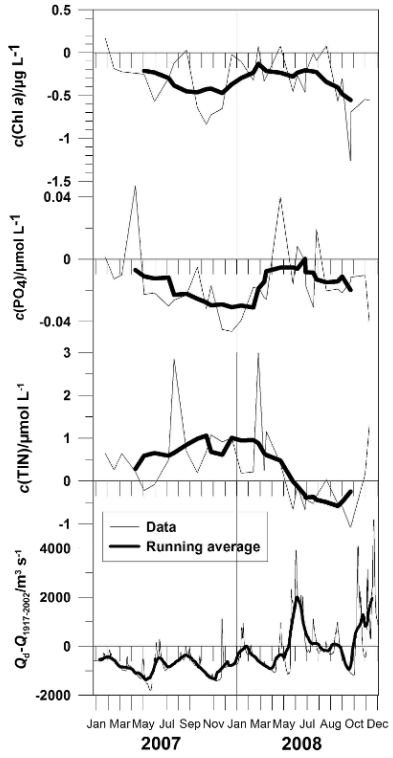


Fig. 2. Residuals (model – 1972-2002 removed) for chlorophyll *a* (Chl *a*), orthophosphate (PO_4) and total inorganic nitrogen (TIN) concentration (*c*), and Po River flow (*Q*) at Pontelagoscuro in the period 2007-2008. Thin line – residuals, thick line – running average

References

1 - Mozetic P., Solidoro C., Cossarini G., Socal G., Precali R., Francé, J., Bianchi F., De Vittor C., Smodlaka N. and Fonda Umani S., 2009. Recent Trends Towards Oligotrophication of the Northern Adriatic: Evidence from Chlorophyll a Time Series. *Estuaries and Coasts*, DOI 10.1007/s12237-009-9191-7.

2 - Precali R. and Djakovac T., 2009. Towards oligotrophication of the northern Adriatic: A reality? ASLO Aquatic Sciences Meeting, Nica, 25-30 Jan 2009, p. 211.

THE FATE OF RHONE RIVER CARBON AND NUTRIENTS IN THE COASTAL MEDITERRANEAN SEA AND ITS RELATION TO CLIMATIC PARAMETERS

C. Rabouille [1]*, C. Estournel [2], J. Naudin [3], O. Radakovitch [4], P. Raimbault [5], R. Buscail [6], B. Deflandre [7], C. Fontanier [8], A. Pruski [9] and P. Bassoulet [10]

[1] Laboratoire des Sciences du Climat et de l'Environnement, UMR CEA-CNRS-UVSQ et IPSL - rabouill@lsce.ipsl.fr
[2] Laboratoire d'Aérologie - Toulouse
[3] Laboratoire d'océanographie Biologique de Banyuls
[4] CEREGE-Aix en Provence
[5] LMGEM-Marseille
[6] CEFREM-Perpignan
[7] EPOC-Bordeaux
[8] BIAF-Université d'Angers
[9] Laboratoire d'océanographie Biologique de Banyuls
[10] IFREMER-Brest

Abstract

The Rhone River exerts a major influence on the Gulf of Lions which is the largest river-dominated ocean margin of the Western Mediterranean Sea. The biogeochemical fate of the Rhone River inputs (dissolved nutrients, particulate organic matter and detrital particles) was investigated during a multi-compartment study (CHACCRA) by coupling simultaneous measurements on the river inputs, the river plume processes and the benthic deposition. A coupled physical-biogeochemical model was used to link the inputs and their fate in the Gulf of Lions and to investigate the sensitivity of the delta system to changes in climate and in river inputs.

Keywords: Deltas, Global Change, Gulf Of Lions, Organic Matter, Rhone Delta

The Rhone River exerts a major influence on the Gulf of Lions which is the largest river-dominated ocean margin of the Western Mediterranean Sea. The biogeochemical fate of the Rhone River inputs (dissolved nutrients, particulate organic matter and detrital particles) to the continental shelf is largely influenced by primary production in the plume, deposition patterns of particles and transformation processes in the water column and sediments. We have designed a multi-compartment study (CHACCRA) by coupling simultaneous measurements on the river inputs, the river plume processes and the benthic deposition to elucidate the transport and transformation of Rhone River material in the Gulf of Lions. A coupled physical-biogeochemical model is used to link the inputs and their fate in the Gulf of Lions. First results from the river input monitoring show that the river input of organic material is highly variable in quantity showing intra and inter-annual variability. The largest change in quality of organic input is linked to the occurrence of floods in the Rhone watershed which may deliver either more reactive carbon (originating from the river bed and runoff on vegetated soils) or less reactive when delivered from erosion of soils. The benthic deposition and transformation of this material shows a spatial pattern with a focus of the deposition of river organic matter as tracked by ^{13}C and ^{14}C signature and an intense recycling of organic particles close to the river mouth. Oxygen demand values close to the Rhone River outlet are around 20 mmol m^{-2} d^{-1}, remain high up to a distance of 10 km around the river mouth above 10 mmol m^{-2} d^{-1} (called the prodelta) and decrease to average continental shelf values further away [1]. This pattern is stable over the seasons but is disturbed by the occurrence of floods which, in the case of June 2008, spread low-reactivity material in the nearshore region and significantly decreased benthic recycling during a few months. The measurements performed during the three cruises dedicated to plume processes showed limited accumulation of Chlorophyll *a* in the Rhone River dilution zone, due to low flow rates during these periods. The structure of the pelagic food web was oriented towards recycling except on a single occasion where marine snow was recorded in the intermediate layer of the water column indicating benthic-pelagic coupling. Overall, a disconnection between river plume production regions occurring on the distant shelf (>30 km) and the hot spot of benthic recycling in the nearshore region is apparent. Biogeochemical modelling coupled to the Symphonie hydrodynamics model in the Gulf of Lion showed a first-order agreement with the timing and amplitude of the winter-spring bloom on the western part of the shelf. The Rhone River plume required specific parametrization, since its biogeochemistry is significantly different from the rest of the Gulf of Lion: stratification is stronger, nutrients are more abundant, the food web is oriented towards larger species. This specific model reproduced the succession of the different nutrients pools and planktonic groups along the Rhone freshwater dilution zone described by [2]. The model was used to characterize the biogeochemical functioning of the Gulf of Lion and to compute associated budgets during several years contrasted by their hydrological and meteorological forcing. The importance of floods and low flow rates on the delivery and fate of organic material to the Rhone prodelta points towards a vulnerability of the ecosystem with respect to climatic change. Climate change should alter both river hydrography due to stronger extreme rains, dry periods and wind patterns in the Northwestern Mediterranean. These changes will be investigated, together with the human impact through the delivery of contaminants and nutrients, in the framework of the newly launched MERMEX programme.

References

1 - Lansard, B., Rabouille, C., Denis, L. and Grenz, C., 2009. Benthic remineralization at the land-ocean interface: A case study of the Rhône River (NW Mediterranean Sea). *Estuar. Coast. shelf Sci.*, 81: 544-554.

2 - Diaz, F., Naudin, J.J., Courties, C., Rimmelin, P., Oriol, L., 2008. Biogeochemical and ecological functioning of the low-salinity water lenses in the region of the Rhone River freshwater influence, NW Mediterranean Sea. *Cont. Shelf Res.*, 28 : 1511-1526.

EVALUATION OF SEDIMENT GENOTOXICITY AND TOXICITY OF THE BERRE LAGOON SEDIMENTS

O. Radakovitch [1]*, S. Rigaud [1], J. Garnier [1], X. Moreau [2], L. Moreau [2], A. Thiéry [2], C. Gueydon [3], L. Malleret [3], P. Doumenq [3], C. Di Giorgio [4] and M. De Méo [4]

[1] CEREGE - Aix Marseille University - radakovitch@cerege.fr

[2] IMEP - Aix Marseille University

[3] ISM2-AD2EM Aix-Marseille University

[4] LBME - Faculté Pharmacie Marseille

Abstract

Trace metals and organic contaminants were analyzed in surface sediments of four sites of the Berre lagoon to determine their potential toxicity and genotoxicity for the benthic fauna. Bioavailable trace metals determined by chemical extractions were compared with bioassimilated contents in Hediste diversicolor as well as with the metallothioneine induction in these organisms. Genotoxic effects were observed for both trace metals and organic contaminants.

Keywords: Metals, Pah, Bio-Indicators, Annelida, Ecotoxicology

In the last decade, numerous assays or indicators were proposed to define the toxicity or genotoxicity of contaminated sediments. They are mostly based on in vitro bioassays and generally refer to one type of contaminant: metal or PAHs. If some tests have been shown to be representative, it is still difficult to evaluate the toxicity associated to a multi-contamination combining organic and inorganic pollutants, and the in situ relationships between these mixtures and their effects on benthic organisms are still unknown.

To better understand such relationships, we conducted a preliminary work using a multi-tool approach on sediments from the Berre lagoon (south of France). This lagoon was impacted in the last century by industrial and urban development introducing large amounts of trace metals and organic contaminants. Their contents decreased in the surface of the sediments since the 1980's but large contents have been accumulated below the surface. These contents in the most impacted area (Vaine lagoon) are up to 160 µg.Kg-1 for total PCBs, 2500 ppm for total PAHs, 80 ppm for Cr, 70 ppm for Ni, 45 ppm de Cu and 140 ppm for Zn.

Four sites characterized by various contaminants contents were sampled and surface sediments were analyzed for trace metals (Cr, Cu, Ni, Pb, Cd, Zn), 16 PAH's and 7 PCB's. The trace metal bioavailibility was studied in more details by comparing labile fractions obtained from Diffusive Gradient Technique (DGT) devices and from several chemical extractions including EDTA 0.1 M, or pH4 and pH6 as physiological pH prevailing in the digestive tract of organisms. In order to show if these various labile pools of metals are representative of the bioavailable form of metals for benthic organisms, we compared their concentrations to the bioassimilated metals contents in the deposit-feeder polychaete Hediste diversicolor (characteristic of coastal sediment) as well as to a metal specific stress marker: the metallothionein (MT) content in cells of the intestinal walls of these organisms. MTs (analyzed by ELISA method) were evidenced in only one site and no relation between MTs and trace metals in the sediment was observed (except for Cd extracted by EDTA). It confirms the rather large variation previously observed for MT induction that can be due to environmental parameters or supplementary detoxification processes [1].

Detection of acting genotoxic and mutagenic pollutants in sediment was tested by the vitro comet assay, the micronucleus assay and the Salmonella mutagenicity test (Ames test) performed on both organic and inorganic extracts of the sediment. The assays performed on organic extracts were conducted with and without metabolic activation (S9 mix) for the detection of both indirect and direct acting genotoxins. The two sites with the highest PAHs and PCBs contents revealed genotoxic and mutagenic effects with a positive dose-response relationship, but only when S9 metabolic activation was added. Furthermore, the strongest genotoxicity was not observed for the most contaminated site. Genotoxic effects associated to trace metals extracts were also observed for the two most contaminated sites, but as for MT there is no direct relationships with total or labile metal extractions.

The responses to the toxicity tests realized in this preliminary work are in rather good agreement with the multi-contaminants contents measured in the sediment. However, information on in situ xenobiotic effects onto organisms and their potential variations with time have to be gained from a future project that will be briefly presented.

References

1 - Amiard J.C., Amiard-triquet C., Barka S., Pellerin J., Rainbow P.S., 2006. Metallothioneins in aquatic invertebrates: Their role in metal detoxification and their use as biomarkers . *Aquatic toxicology*. 76, 160-202.

NITROGEN FIXATION, PRIMARY AND BACTERIAL PRODUCTIVITY RATES IN TWO DISTINCT WATER PROVINCES IN THE LEVANTINE BASIN

E. Rahav [1]*, E. Bar-Zeev [1], G. Dishon [1], M. Mulholland [2], B. Herut [3] and I. Berman-Frank [1]
[1] Mina and Everard Goodman Faculty of Life Sciences, Bar-Ilan University, Ramat Gan 52900, Israel - eyalrahav@gmail.com
[2] Department Ocean, Earth, and Atmospheric Sciences, Old Dominion University, Norfolk, Virginia 23529, USA
[3] Israel Oceanographic and Limnological Research, National Institute of Oceanography, Haifa 31080, Israel

Abstract
Nitrogen fixation, bacterial and primary productivity rates were measured along an 12 eutrophication gradient at two distinct provinces in the Levantine basin: the Shikmona 13 gyre (SG) and the Rhodes gyre (RG). Primary productivity in the euphotic zone ranged 14 from 0.37 mmol C m-3 d-1 for oligotrophic SG to 1.67 mmol C m-3 for moderately 15 mesotrophic RG. Bacterial productivity ranged between 0.08 µg C L-1 d-1 at surface and 16 5.11 µg C L-1 d-1 at the bottom depths of the SG, while the RG showed extremely high 17 rates, ranging from 6.3 to 87.8 µg C L-1 d-1 at the surface and bottom, respectively.
Keywords: Levantine Basin, Nutrients

The Levantine basin in the east Mediterranean Sea is one of the most oligotrophic, low nutrient low Chlorophyll (LNLC) seas especially during stratification periods. The deep waters of the Levantine basin have an anomalousy high nitrate to phosphate ratio (DIN:DIP) (28:1) and all its input sources, particularly atmospheric sources ([1]), show a high N:P ratios (>16:1) ([2]). In addition, its P turnover time (<5h, 26 [3]) is typical for P deficient water systems. Thus, it is expected that these properties do not favor significant N-fixation rates. Indeed, routinely monitored stations in the ultraoligotrophic waters off the Israeli coast (2006-2008), showed extremely low or undetectable rates of N-fixation (0-1.3 nmol N L-1 d-1) (Yogev et al., - in prep). Low N2 fixation rates were also recorded in the Gulf of Aqaba, Red Sea, during fall (stratified, oligotrophic) and spring (deep mixing, mesotrophic) seasons with maximum rates of 1 ± 32 0.1 nmol N L-1 d-1 in the fall and 1.9 ± 0.2 nmol N L-1 d-1 in the spring ([4]).

Theoretically, nitrogen fixers (i.e., large colonial cyanobacteria in the genus *Trichodesmium* and the heterocystous endosymbiont *Richelia*) could prosper in environments which supply phosphorus and iron to feed the energetic and enzymatic demands for the Fe-rich nitrogenase and N fixation process. Such conditions may occur along a eutrophic gradient in specific areas in the Levantine Basin. Indeed, an order of magnitude higher N fixation rates were measured in Haifa bay during May 2009 (8 nmol 40 N L-1 d-1) representing a more mesotrophic environment. To understand the factors controlling this process we explored N fixation rates, primary and bacterial production in two distinct water provinces in the Levantine basin, the ultra-oligotrophic Shikmona Gyre and the mesotrophic Rhodes Gyre.
The Shikmona gyre (SG), also referred to as the Cyprus eddy, is a warm-core eddy with an anti-cyclonic circulations patterns and is characterized with nitrate and phosphate values close to the conventional analytical detection limits in the surface waters (a few nanomolars during stratified period, [5]), development of deep chlorophyll maximum (125 m) and low values of primary productivity (0.37 mmol C m-3 d-1). TheRhodes gyre (RG) is a cyclonic feature of the eastern Mediterranean circulation and characterized with constant upwelling with relatively high nitrate and phosphate concentration at surface (0.2 µM and 0.02 µM, respectively), shallow chlorophyll maximum (60 m) and relatively higher rates of primary productivity (1.67 mmol C m-3 d-53 1).

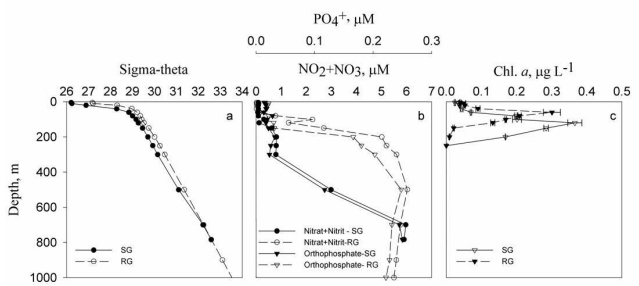


Fig. 1. Depth profiles measured during July 2009 from the Shikmona and Rhodes gyres showing changes in water density (a), dissolved concentrations of nitrate+nitrite and orthophosphate (b) and concentrations of extracted Chlorophyll *a* (c)

Water was collected on July 2009 at the above locations onboard the R/V 55 Mediterranean Explorer, during the ISRLEV cruise. Rates of nitrogen fixation were measured on field samples using the 15N2 assimilation technique ([6]). Bacterial production was estimated using 3H-Leucine (Amersham, Specific activity: 160 Ci/mmol) incorporation method ([7]). Photosynthetic carbon fixation rates were estimated by means of the 13C technique ([8]).

References
1 - Herut, B., R. Collier, et al., 2002. "The role of dust in supplying nitrogen and phosphorus to the Southeast Mediterranean." *Limnology and Oceanography* 47 (3): 870-878.
2 - Krom, M. D., B. Herut, et al., 2004. "Nutrient budget for the Eastern Mediterranean: Implications for phosphorus limitation." *Limnology and Oceanography 49*(5): 1582-1592.
3 - Kress, N., T. F. Thingstad, et al., 2005. "Effect of P and N addition to oligotrophic Eastern Mediterranean waters influenced by near-shore waters: A microcosm experiment." *Deep-Sea Research* Part Ii-Topical Studies in Oceanography 52(22-23): 3054-3073.
4 - Foster, R. A., A. Paytan, et al., 2009. "Seasonality of N-2 fixation and nifH gene diversity in the Gulf of Aqaba (Red Sea)." *Limnology and Oceanography* 54(1): 219-233.
5 - Krom, M. D. and others., 2005. Nutrient cycling in the south east Levantine basin of the eastern Mediterranean: Results from a phosphorus starved system. *Deep-Sea Res.* Part II-Top. Stud. Oceanogr. 52:2879-2896.
6 - Montoya, J. P., M. Voss, et al., 1996. "A simple, high-precision, high-sensitivity tracer assay for N-2 fixation." *Applied and Environmental Microbiology* 62(3): 986-993.
7 - Simon, M., and F. Azam., 1989. Protein-content and protein-synthesis rates of plantonic marine-bacteria. MARINE-BACTERIA. *Mar. Ecol.-Prog. Ser.* 51**:** 201-213.
8 - Pimenov, N. V., A. M. Zyakun, et al., 2008. "Application to C-13 mineral carbon for assessment of the primary production of organic matter in aquatic environments." *Microbiology* 77(2): 224-227.

EFFECTS OF THE HYDROLOGICAL CONDITIONS ON THE SPATIAL DISTRIBUTION OF CHLOROPHYLL A AND NUTRIENTS CONCENTRATIONS IN AN UPWELLING AREA OF THE ALBORAN SEA

Teodoro Ramírez [1], Dolores Cortés [1], Jesús Mercado [1] and Esperanza Liger [2]*
[1] Department of Applied Physics II, University of Málaga - eliger@uma.es
[2] Instituto Español de Oceanografía, Centro Oceanográfico de Málaga

Abstract
The coupling between the spatial distribution of Chla (chlorophyll-a) and nutrient concentrations and the hydrological conditions in the NW Alboran Sea is examined in the present study by using data from 12 seasonal oceanographic cruises carried out over three years period.
Keywords: Chlorophyll-a, Nutrients, Alboran Sea, Upwelling

Introduction
The Alboran Sea is characterized by a very high hydrodynamic activity. The Atlantic seawater influx through Strait of Gibraltar produces a system of two anticyclonic gyres which occupy almost all the central part of the basin [1]. With the aim of providing new insights on the coupling among biological structures and the hydrology in this area [2-3], four seasonal oceanographic cruises per year were carried out along the coast of Malaga.

Material and Methods
Samplings were conducted in coastal (20-30 m), neritic (80-100 m) and oceanic stations (210-540 m), situated in six transects located off the coast of Málaga (Fig.1). At each sampling station, continuous vertical profiles of temperature and salinity and seawater samples for Chla and nutrient analysis were taken. The mean values of these variables in the upper 20 m during each cruise were used to generate horizontal distributions maps for the whole period of study.

Results and Discussion
Salinity and temperature in the upper 20 m reflected the general circulation pattern of the zone as well as the influenced of different fertilization mechanisms. Thus the oceanic stations of the western transects (P, F and T) were frequently under the influence of the Atlantic jet, where lower temperature values coincided with the lowest average salinity, possibly due to the incursions of cores of North Atlantic Central Water (NACW) in these stations. The eastern transects (M, R and V) were usually affected by warmer waters from the East and with relatively low salinities and high dissolved oxygen values, suggesting the presence in the eastern transects of surface water with a high residence time. On average, salinity showed a strong gradient towards the coast on the whole area, mainly due to the wind induced upwelling events in the coastal stations. This gradient was even more pronounced in the westernmost transects due to the greater Atlantic influence in the oceanic stations. Nutrient concentrations correlated significantly with salinity, showing the potential fertilization associated to the saltier Mediterranean waters. However, no correlation was found with neither the temperature nor the depth of the AMI (Atlantic Mediterranean Interface). Chla was greatly affected by the hydrological conditions and showed significant differences between the western and the eastern transects (Kruskal-Wallis, H (N=24)=13.96, $p<0.001$). In the western transects different fertilization mechanisms (geostrophic front, incursions of NACW and advection waters from the Strait of Gibraltar) leaded to the highest Chla values found during the studied period, which on average were always higher than 1 $\mu g\ L^{-1}$. In the eastern sector, Chla concentrations were always lower than 0.7 $\mu g\ L^{-1}$, coinciding with the presence in these transects of waters with a higher time of residence. In the Alboran Sea, the depth of the AMI (Atlantic Mediterranean Interface) has been frequently considered as an indicator of fertilization by different authors [1], as the Mediterranean waters are enriched in nutrients, and relationships between Chla and the AMI has been previously reported. However, the present study indicated that on overall the depth of the AMI was no good predictor of the vertical nutrient input towards the surface, though salinity did. In addition, no significant correlation was found neither between the mean values of Chla and salinity in each station, nor between Chla and the depth of the AMI. In contrast, Chla concentrations correlated significantly with the average temperature, dissolved oxygen and nutrient concentrations in the upper 20 m, indicating a close association between Chla concentrations and the thermal and biogeochemical features of the water masses. The lack of correlation between Chla and salinity was attributed to the existence of different fertilization mechanisms in the area of study, not only the upwelling of saltier Mediterranean of waters, as well as to the presence of water masses with different times of residence.

Acknowledgements. This work has been funded by IEO (ECOMALAGA project) and Spanish Ministry of Science and Innovation (NITROALBORAN CTM2006-00426 and TROFOALBORAN CTM2009-07776, co-funded from FEDER-EU).

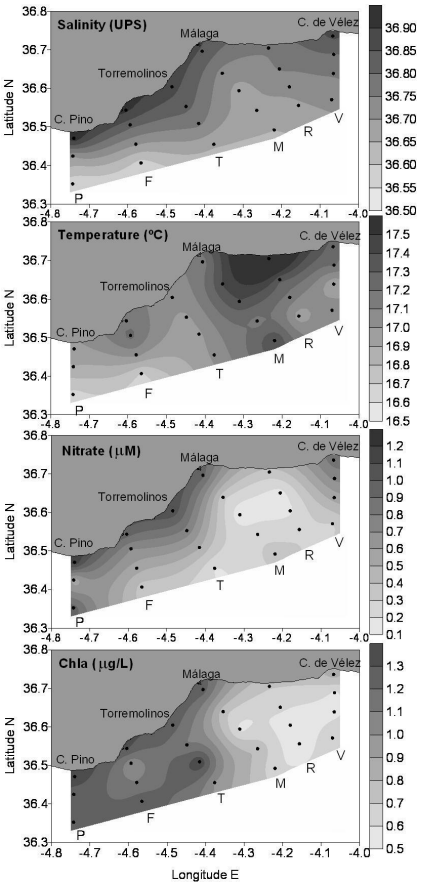


Fig. 1. Spatial distribution of the different variables in the study area

References
1 - Rodríguez, J., Blanco J.M., Jímenez-Gómez, F., Echevarría, F., Gil, J., Rodriguez, V., Ruiz, J., Bautista, B., Guerrero, F., 1998. Patterns in the size structure of the phytoplankton community in the deep fluorescence maximum of the Alboran Sea (southwestern Mediterranean). *Deep Sea Research I*, 45: 1577-1593.
2 - Ramírez, T., Cortés, D., Mercado, J.M., Vargas-Yañez, M., Sebastián, M., Liger, E., 2005. Seasonal dynamics of inorganic nutrients and phytoplankton biomass in the NW Alboran Sea. *Estuarine Coastal and Shelf Science* 65 (4), 654-670.
3 - T. Ramírez. *PhD* Thesis, University of Málaga (2007).

ORIGIN OF SEDIMENTARY ORGANIC MATTER AND HUMIC ACIDS IN THE GRADO AND MARANO LAGOON

Federico Rampazzo [1], Daniela Berto [1]*, Stefano Covelli [2] and Michele Giani [3]
[1] Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA) Chioggia, Italy - d.berto@icram.org
[2] Dipartimento di Geoscienze, Università di Trieste, Italy
[3] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy

Abstract
In the framework of the MIRACLE project (Mercury Interdisciplinary Research for Appropriate Clam farming in Lagoon Environment), sediment cores were sampled in the Grado and Marano lagoon and in the tributary Aussa River in order to quantify and to characterize humic acids (HA) that are recognized to play an important role in complexing heavy metals, mercury included. Stable carbon isotopic composition was used to identify sources and contribution of organic matter from different environments to lagoon sediments.
Keywords: Organic Matter, Lagoons, Carbon, Chemical Analysis

Introduction
A substantial fraction of the so-called refractory organic matter in sediments is constituted by humic substances (HS) which are formed from the decomposition of plant, animal and microbial tissues and tend to be more recalcitrant than their precursors. HS can play an important role as electron transfer in the anaerobic environment [1]. HS they can bind both hydrophobic and hydrophilic species [2] and are electron donors in photo-oxidation reactions in marine environments [3]. The aim of the present work is to investigate the relevance and the origin of humic acids in the sedimentary organic matter of the Grado and Marano Lagoon.

Methodology
The sediments, surface layer (0-1 cm) and a sub-surface layer (5-6 cm), were collected in 16 stations in the Grado and Marano lagoon and in the Aussa River. Organic carbon (C_{org}) was determined in sediments and humic acids extracted by a CHNS-O elemental analyzer after removal of carbonates with HCl 1N [4]. Nitrogen (N) was determined following the same procedure, without acidification. The detection limit of the method was 0.4 micromole for C_{org} and 0.9 micromole for N. The stable isotopic ratio of organic carbon ($^{13}C/^{12}C$) was determined by a CHNS-O analyzer coupled with an Isotope Ratio Mass Spectrometer. The analytical precision of measurements was 0.2%. The extraction of HA from sediments was performed following the methods of the International Humic Substance Society, modified by Moreda-Piñeiro et al. [5] .

Results and discussion
The contribution of humic C to total C_{org} was high both in lagoon and riverine sediments (~ 30 %). The concentrations in riverine sediments were the highest and increased upstream from the river mouth. This relevant amount of humic acid to the sedimentary organic matter points out their important role in the transformation and accumulation of organic material in the lagoon environment. The $^{13}C/^{12}C$ ratios for the sedimentary organic matter showed a prevalently marine/lagoon origin whereas the riverine sediments appeared significantly more depleted in $^{13}C/^{12}C$ (more negative ^{13}C) along with the highest C/N ratios, due to the fluvial and terrestrial origin of the organic matter [Fig. 1].

Extracted humic substances showed similar $^{13}C/^{12}C$ values of the corresponding sediments [Fig. 1], but higher C/N ratios, in particular in the subsurface ones. This increase with depth seems to indicate that different stages of transformation of the organic matter take place during early diagenesis.

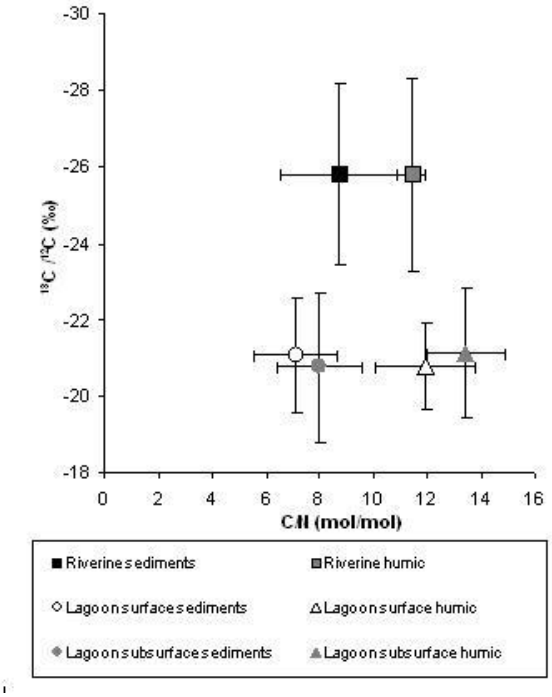


Fig. 1. Stable carbon isotope ratios ($^{13}C/^{12}C$) of organic carbon vs C/N molar ratios in river Aussa, in lagoon surface and subsurface sedimentary organic matter and in corresponding extracted humic acids.

References
1 - Lovley D.R., Coates J. D., Blunt-Harris E.L., Phillips E.J. P. and Woodward J.C., 1996. Humic substances as electron acceptors for microbial respiration. *Nature*, 382: 445-448.
2 - Lafrance P., Banton O., Campbell P.G.C. and Villeneuve J.P., 1990. A complexation-adsorption model describing the influence of dissolved organic matter on the mobility of hydrophobic compound in groundwater. *Wat. Sci. Technol.*, 22: 15-22.
3 - Zepp R.G., Braun A.M., Hoigne J. and Leenheer J.A., 1987. Photoproduction of hydrated electrons from natural organic solutes in aquatic environments. *Environ. Sci. Technol*., 21:485- 489.
4 - Nieuwenhuize J., Maas, Y.E.M., Middelburg J.J., 1994. Rapid analysis of organic carbon and nitrogen in particulate materials. *Mar Chem*., 45: 217–224.
5 - Moreda-Piñeiro A., Barrera A. B., Barrera P.B., 2004. New trends involving the use of ultrasound energy for the extraction of humic substances from marine sediments. *Anal. Chim. Acta*, 524: 97–107.

MUSSEL DNASE ACTIVITY AS A NEW BIOMARKER FOR ENVIRONMENTAL CONTAMINATION: RESPONSE TO MODEL POLLUTANTS

Sanda Ravlic [1]*, Mirta Smodlaka [1] and Nevenka Bihari [1]
[1] Center for Marine Research, Rudjer Boskovic Institute - ravlic@cim.irb.hr

Abstract
In this study the determination of pollutant effect on acid DNase activity was performed on mussel *Mytilus galloprovincialis* hemocytes and hepatocytes. The specific enzyme activity in unexposed mussels from mariculture area was higher in hemocytes than in digestive gland. Acid DNase activity response to detergent, gasoline and copper sulphate exposure was both pollutant- and tissue-specific.
Keywords: Mollusca, Ecotoxicology, Enzymes, Toxins

Introduction
Mussels adjust their function to environmental changes by reacting to various contaminants accumulated from the surrounding water and serve as bioindicators of coastal water quality. The aim of this study was to investigate the changes in the specific acid DNase activity in the mussel *Mytilus galloprovincialis* exposed to three types of model pollutants, a detergent as a surfactant, gasoline as a polycyclic aromatic hydrocarbon mixture and copper as a heavy metal. Digestive gland as a detoxifying organ and hemocytes as a major internal defense tissue were selected as target organs.

Materials and methods
The mussel *M. galloprovincialis*, average mass 10± 2 g and length 4± 1 cm were obtained from mariculture and served as a control group and reference sample. Mussels (30 specimens) were exposed in 201 tanks to ariel detergent (0.05, 0.5 or 5 mg/l), gasoline (0.05, 0.5 or 5 mg/l) or copper sulphate, $CuSO_4x\ 7H_2O$ (2.5, 25, or 250 mg/l) for 3 days. DNase activity was measured fluorometrically by a method originally developed for neutral DNases [1] and adapted to acid DNases [2].

Results and discussion
Comparison of specific acid DNase activity in hemocytes and digestive gland of control mussels revealed hemocytes as a tissue with the higher enzyme activity. This result indicates that the requirement for enzyme activity is headed to restriction of DNA in the process of phagocytosis in hemocytes. Acid DNase activity response in hemocytes and digestive gland of mussels exposed to detergent, gasoline and copper sulphate is presented in Fig. 1A. In specimens exposed to detergent or gasoline the significant increase in enzyme activity was observed in both tissues. The highest enzyme activity was detected in mussels exposed to gasoline. A dramatic change in acid DNase activity was observed in the digestive gland of mussels exposed to gasoline and copper sulphate. Exposure to copper sulphate increased enzyme activity in the digestive gland but significantly suppressed it in hemocytes. Detergent and copper sulphate induced a fast response (24 h) of the enzyme activity in both tissues (Fig. 1B1, 1B3) while metabolic biotransformation of lipophylic constituents was probably the cause of the delayed enzyme response (48 h in hemocytes and 72 h in digestive gland) to gasoline (Fig. 1B2). Suppression of enzyme activity as a specific response of hemocytes acid DNase to copper sulphate is consistent with its effect on the cells of the immune system in bivalves [3]. Acid DNase activity response in hemocytes and digestive gland of mussels exposed to model pollutants was both tissue- and pollutant specific but the potential of acid DNase response in digestive gland of mussel to serve as an "all or nothing response" biomarker of contaminant exposure is promising.

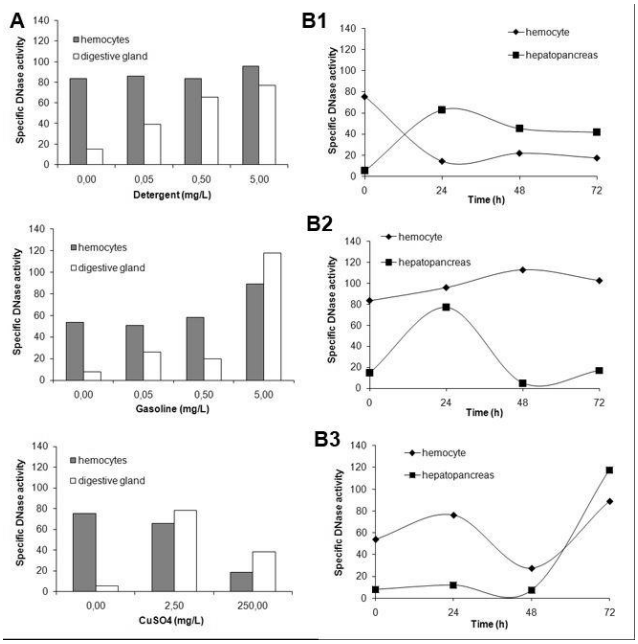


Fig. 1. Dose (A) and time (B1, B2, B3) response of acid DNase activity of hemocytes and the digestive gland of the mussel Mytilus galloprovincialis to different pollutants. B1- detergent (5 mg/l), B2- gasoline (5 mg/l), B3- copper sulphate (250 mg/l).

References
1 - Choi, S.-J.,Szoka, F.C., 2000. Fluorometric determination of deoxyribonuclease I activity with Picogreen. *Anal.Biochem*. 281, 95-97.
2 - Fafandel, M., Bihari, N., Peric, L., Cenov, A., 2008. Effect of marine pollutants on the acid DNase activity in the hemocytes and digestive gland of the mussel *Mytilus galloprovinciallis. Aquat. Toxicol*. 86, 508-513.
3 - Anderson, R., Mora, L., Thompson, S., 1994. Modulation of oyster (Crassostrea virginica) hemocyte function by copper as measured by luminal-enhanced chemiluminiscence. *Comp. Biochem. Physiol*. C 108, 218- 220.

METALS AND POPS IN SEDIMENTS ALONG THE ITALIAN ADRIATIC AND IONIAN COAST

S. Romano [1]*, C. Mugnai [1], S. Giuliani [1], L. G. Bellucci [1] and M. Frignani [1]
[1] CNR - ISMAR UOS Bologna - stefania.romano@bo.ismar.cnr.it

Abstract
Concentrations of inorganic and organic contaminants along the costal zone of the Adriatic and Eastern Ionian Seas in the central-southern part of Italy were obtained from the Ministry of Environment database and analysed to assess the quality of these areas, and understand their variability and its main causes. Peak values were found mainly in occasion of floods, which deliver land based contaminated materials to the coastal zone. To evaluate both contamination degrees and potential ecotoxicological effects, the values of metals, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) were compared with sediment quality guidelines (SQGs). The mean concentrations are mostly below the lower SQGs, although maxima are higher, in some cases exceeding the limit above which adverse effects are expected.
Keywords: Metals, Pcb, Pah, Sediments

Introduction
The presence of urban areas, ports and industrial settlements is one of the main factors influencing the quality of coastal marine environments. This work aims to assess near-shore sediment quality and variability along the central-southern Adriatic coast of Italy, based on the data from Si.Di.Mar., web GIS of the Italian Ministry of Environment Marine Monitoring program, that stores information on contaminants in environmental matrices.

Material and Methods
We considered surficial sediments (0-3 cm) sampled every six months at 16 selected sites along the coast of Marche, Abruzzo, Molise and Puglia by Regional Environmental Protection Agencies in the years 2001-2006. Sampling areas, located within 1NM from the coastline, were selected among those subject to anthropogenic pressures, in general close to river mouths, ports and urban areas. In addition, a reference station, located inside a Protected Marine Area, was chosen for each region. The analysed contaminants include metals (Cd, Hg, Ni, Zn) and POPs (PAH and PCB priority congeners). Sediment characteristics, such as grain size composition, total (TC) and organic carbon (OC) contents, were also determined.

Results and discussion
The grain size composition indicate a predominance of sand at all sites, with significant fluctuations that can be attributedto increases of system dynamics and/or significant inputs of coarse material from land. OC concentrations are relatively high (0.02-3.00%), which is rather peculiar in coarse sediments. Contaminant concentrations show a decreasing trend, except for PAHs (Fig. 1). Pattern of both sediment characteristic and contaminants are similar on the regional scale.

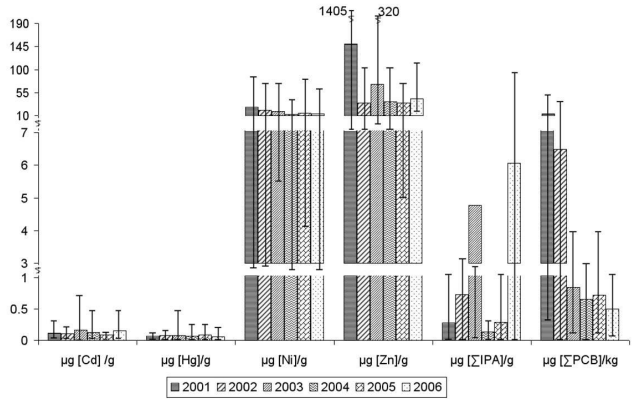


Fig. 1. Average values calculated annually for the whole study area for metals, ∑PCB and ∑PAH. The vertical bars show the maximum and minimum values.

Sediment quality guidelines (SQGs) are useful screening tools to asses the potential toxicity of contaminants in sediments in absence of direct biological effect data [1].
Table 1 shows a comparison of the contaminant data with different SQGs adopted for the Italian contest [2] and worldwide [3], [4], [5].

Tab. 1. Mean, minimum and maximum values for the whole study area on yearly basis for metals, ∑PCB and ∑PAH. The sediment quality guidelines used for comparison are listed above.

		Cd (µg/g)	Hg (µg/g)	Ni (µg/g)	Zn (µg/g)	∑IPA(µg/g)	∑PCB(µg/kg)
[2] LCB (fines <10%)	*	0.20	0.20	40.0	50.0	0.90	5.00
[2] LCL	**	0.80	0.80	75.0	170	4.00	189
[3] ERL	▪	1.20	0.15	20.9	150	4.00	22.7
[3] ERM	▪▪	9.60	0.71	51.6	410	45.0	180
[4] TEL	•	0.68	0.13	15.9	124	0.62	22.0
[4] PEL	••	4.21	0.70	42.8	271	15.2	180
[5] TEC	+	0.99	0.18	23.0	120	1.61	60.0
[5] PEC	++	5.00	1.10	49.0	460	22.8	676
2001	mean	0.12	0.06	26.2	150 *	0.28	13.0 *
	min	0.05	0.01	1.94	7.40	0.00	0.20
	max	0.34 *	0.10	‡‡75.1▪▪	‡‡1405▪▪	•1.30 *	47.8 *
2002	mean	0.10	0.07	20.3	35.2	0.73	6.48 *
	min	0.01	0.02	2.10	6.68	0.00	0.01
	max	0.28 *	0.14	‡‡ 60.8 ‡▪	107 *	‡3.20 *	• 40.1 *▪
2003	mean	0.17	0.08	17.9	71.2 *	0.48	0.85
	min	0.02	0.01	5.40	7.82	0.02	0.10
	max	•0.68 *	‡0.50 ‡▪	‡‡61.0 ‡▪	‡• 320*▪	‡1.98 *	4.00
2004	mean	0.12	0.07	12.7	37.5	0.13	0.66
	min	0.04	0.01	1.70	6.66	0.01	0.01
	max	0.50 *	‡0.22 ‡▪	‡35.5 ▪	107 *	0.31	2.93
2005	mean	0.08	0.08	14.3	34.4	0.29	0.72
	min	0.01	0.01	4.10	5.00	0.02	0.09
	max	0.20 *	‡0.25 ‡▪	‡‡58.7‡▪	67.0 *	•1.04 *	3.97
2006	mean	0.15	0.06	14.1	43.1	6.05 *	0.50
	min	0.03	0.02	2.03	14.0	0.02	0.05
	max	0.47 *	• 0.17▪	‡‡54.6 ‡▪	114 *	‡‡ 94.0‡▪	1.20

The annual mean values are mostly below the lowest benchmark, whereas maxima are usually higher, sometimes exceeding the upper limit above which adverse effects are expected (Table 1). This was observed for Hg (2003, 2004, 2005), Ni (each year except 2004), Zn (2001, 2003) and PAHs (2006). The main cause of the peak contaminant inputs recorded by sediment can be related to the particular rain regime in the last decades, which has been characterised by both a reduction of average precipitations and a higher occurrence of extreme events. These, apparently, have the capacity to mobilise contaminants stored on land and deliver them to the coastal zone.

Acknowledgements
Thanks are due to G. Pelliccia, G. Marchionne and D. Buzzi of the Pescara Province. The work was carried out within the INTERREG IIIA "O.A.S.I.S."

References
1 - Casado-Martinez M.C., Buceta J.L., Belzunce M.J. and DelValls T.A., 2006. Using sediment quality guidelines for dredged material management in commercial ports from Spain. *Environ Int.* 32: 388-396.
2 - APAT & ICRAM 2007. Manuale per la movimentazione dei sedimenti marini.
3 - Long E.R.D., MacDonald D.D., Smith S.L. and Clader F.D. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediment. *Environ. Manage.* 19: 81-97.
4 - MacDonald D.D., Carr R.S., Calder F.D., Long E.R. and Ingersoll C.G. 1996. Development and evaluation of sediment quality guidelines for Florida coastal waters. *Ecotoxicology* 5: 253-278.
5 - Wisconsin Department of Natural Resources, 2003. Consensus - Based Sediment Quality Guidelines; Recommendations for Use & Application WT-732 2003:17-19.

PROPERTIES OF PERIODIC DYNAMICAL SYSTEMS MODELING: THE DIMETHYLSULFIDE(DMS)CYCLE

B. Rossetto [1]*, J. Ginoux [1], N. Jean [1], J. Jamet [1], D. Jamet [1], G. Boge [1] and S. Richard [1]
[1] Toulon University - rossetto@univ-tln.fr

Abstract
The variables of a model of dimethylsulfide (DMS) cycle and their interactions are analyzed in order to fit Mediterranan sea data. The outcome is a class of dynamical systems with periodic coefficients. A method to determine some mathematical properties conferred by these systems to the phase space is proposed to extract some information from the complexity of the solutions.
Keywords: Models, Geochemistry

Introduction
The dimethylsulfide (DMS) cycle of ecosystems may contribute to moderate anthropogenic forcing of climate. This field gives rise to a broad interest and to a large number of papers, but the magnitude of the DMS-climate feedback is difficult to appreciate.

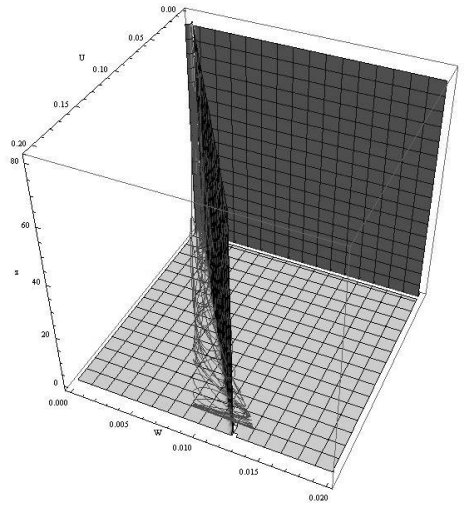


Fig. 1. Manifold (dark) and solutions trajectories in the three dimensional phase space DMS (U), DMSP (W), zooplankton (z)

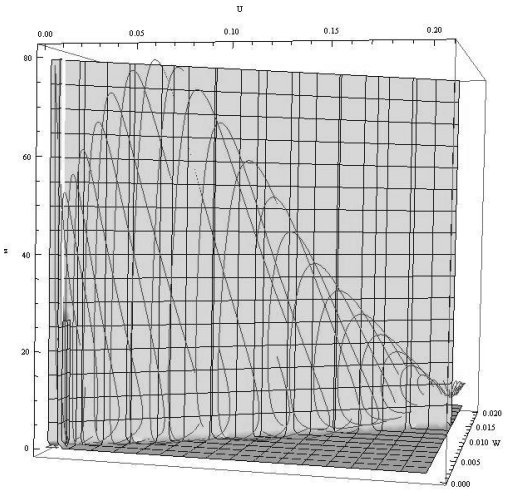


Fig. 2. Other perspective of the same phase space representation

Biologic study
The first part of this work is devoted to the construction of a model of the biogeochemical cycle of DMS based on works of A. J. Gabric & al.[1] and on experimental data from Mediterranean sea consisting in samplings of nutrients, phytoplankton, zooplankton and physical parameters such temperature, salinity and photometry [2]. The variables of an eight-dimensional mathematical model are concentration of phytoplankton, bacteria, zooflagellates, large protozoa, micro and mesozooplankton, dissolved inorganic nitrogen, dissolved dimethylsulfonio-propionate (DMSP) and dissolved DMS. The air-sea exchange of DMS depends in a complex way on the wind velocity and on the sea surface temperature (SST), which is a function of time. So, the original model is an eight-dimensional dynamical system with variable coefficients. At first, a numerical study allows to determine what variables have a significant influence in the DMS cycle, according the environment, in order to reduce the number of dimensions of the dynamical system. It is shown that, under some conditions, the three variables zooflagellates, large protozoa, micro and mesozooplankton, can be merged. Then, the nutrients can be introduced are an external input. So, the dimensions are reduced to five.

Mathematical study
Let us consider, for example, the dissolved DMS and DMSP concentrations. With some set of data, they autonomously oscillate with an irregular period of about one month. The high number of dimensions and this irregular oscillation contribute to the complexity of the solutions. The equation of an invariant manifold of an associated constant coefficient equivalent system (ACCES) is computed in a very simple way using differential geometry results [3]. This manifold plays an important role when the coefficients of the dynamical system depend on time [4]. When there is no wind, this manifold shows that the dissolved DMS and DMSP concentrations variations are almost synchronized. In the presence of wind, the manifold is periodically crossed by the solutions of the model as it is shown on the two figures, which are two perspectives of the projection of the same phase space on the (DMS, DMSP, zooplankton) tridimensional space. Then the DMS and DMSP respective influence is modulated by the sea surface temperature.

Conclusion
The respective influence of other set of variables could be studied by this method.

References
1 - Gabric A. J., Gregg W., Najjar R., Erickson D., Matrai P., 2001. Modeling the biogeochemical cycle of dimethylsulfide in the upper ocean: a review. *Chemosph. Global Change Sc.* 3: 377-392.
2 - Jean N., Bogé G., Jamet J.-L., Jamet D., 2006. Comparison of b-dimethylsulfoniopropionate (DMSP) levels in two mediterranean ecosystems with different trophic levels, *Mar. Chem.* 101: 190-202.
3 - Ginoux J.-M., Rossetto B., Chua L., 2008. Slow Invariant Manifolds as Curvature of the Flow of Dynamical Systems, *Int. J. Bifurcation & Chaos* 18 (11): 3409-3430.
4 - Rossetto B., Ginoux J.-M., 2009. Periodic dynamical systems in the phase space. *Int. Conf. on Complex Systems and Applications (ICCSA'09)*, Le Havre (France).

ASSESSMENT OF ZINC MOBILIZATION IN COASTAL SEDIMENTS

A. Sakellari [1]*, M. Plavsic [2], S. Karavoltsos [1], M. Dasenakis [1] and M. Scoullos [1]
[1] National and Kapodistrian University of Athens, Dept. of Chemistry, Section III, Laboratory of Environmental Chemistry, Panepistimiopolis 157 71, Athens, Greece - esakel@chem.uoa.gr
[2] Ruder Boskovic Institute, Center for Marine and Environmental Research, P.O. Box 180, 10002 Zagreb, Croatia

Abstract
The mobility of zinc in sediments of selected coastal microenvironments of the Aegean Sea (Greece) was investigated with the implementation of the DGT (Diffusive Gradients in Thin Films) technique. The various forms of zinc in sediments – together with those of iron and manganese –determined through sequential extraction schemes, their profiles in pore water and the impact of organic matter, including carbohydrates, were taken into consideration. A case of zinc flux from the sediment to the overlying water was investigated.
Keywords: Zinc, Sediments

Introduction
Heavy metals may be recycled several times through the sediment-water interface before being permanently stored in sediments or released to the overlying bottom waters. Pore water represents an important intermediate in this mobilization procedure, which is influenced by diagenetic reactions, prevailing redox conditions and microbial activity, with organic matter playing a major role via complexation [1]. Through the vertical profiles of metals' concentrations in pore water, the role of diagenetic reactions and the resupply of metals from sediments can be evaluated [2].

Methodology
The total metal content of sediment cores and their various forms according to the BCR sequential extraction scheme were determined by GFAAS. High resolution concentration depth profiles of metals were obtained by the *in situ* technique of DGT (Fig. 1). Organic carbon was measured by High Temperature Catalytic Oxidation and carbohydrates in sediments were measured colorimetrically by the phenol-sulfuric acid method, whereas in pore water according to Myklestadt et al [3].

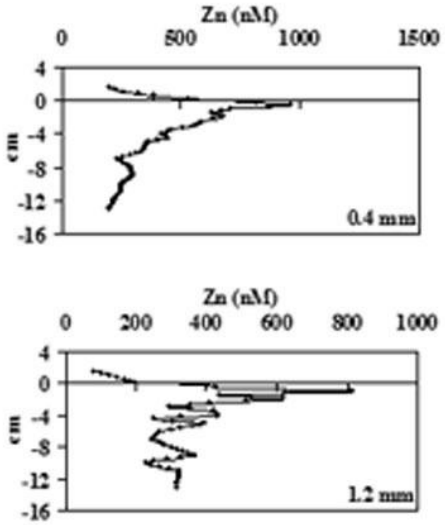


Fig. 1. Concentration depth profiles of the DGT fraction of dissolved zinc in sediment pore water from Loutropyrgos site.

Results and Discussion
At the sites of Loutropyrgos (Saronikos gulf) and Kalamos (Evoikos gulf) the vertical distributions of total metals and organic matter in the solid phase of the sediment demonstrate similar fluctuations with metal profiles in pore water. On the contrary, this is not the case at Molos site (Maliakos gulf), probably due to prevailing turbation. Metal mobility in the cores studied is regulated by the forms under which metals occur in sediment and is significantly affected by diagenesis and the transformations of organic matter. These reactions are largely responsible also for the flux of metals from the sediment to the pore waters [4].
At the site of Loutropyrgos, located at one of the mostly industrialized areas of the country, a flux of both zinc (Fig. 1) and organic matter from the sediment to the overlying water is likely to occur. Through the formation of a constant concentration gradient in the sediment-water interface an enrichment of the overlying water in zinc, dissolved organic carbon and carbohydrates takes place. This is confirmed by the higher concentrations of zinc, dissolved organic carbon and carbohydrates detected in seawater samples obtained from the area near the sediment-water interface, in comparison to those collected from upper layers.

References
1 - Burdige D.J., 2002. Sediment pore waters. *In*: Hansell D.A. and Carlson C.A. (eds.), Biogeochemistry of marine dissolved organic matter. Elsevier Science, Academic Press, California, pp 612-663.
2 - Zhang H., Davison W., Mortimer R.J.G., Krom M.D., Hayes P.J. and Davies I.M., 2002. Localised remobilization of metals in a marine sediment. *Sci.TotalEnviron.*, 296: 175-187.
3 - Myklestadt S.M., Skanoy E. and Hestmann S., 1997. A sensitive and rapid method for analysis of dissolved mono- and polysaccharides in seawater. *Mar. Chem.*, 56: 279-286.
4 - Zhang H., Davison W., Miller S. and Tych W., 1995. *In situ* high resolution measurements of fluxes of Ni, Cu, Fe and Mn and concentrations of Zn and Cd in porewaters by DGT. *Geochim. Cosmochim. Acta*, 59: 4181-4192.

GEOCHEMICAL STUDIES OF THE ENVIRONMENTALLY MOBILE METAL FRACTION IN BOX CORES FR0M THE MESSINIAKOS GULF (GREECE)

Fani Sakellariadou [1]*

[1] Professor in Marine Geochemistry, University of Piraeus, Dept of Maritime Studies - fsakelar@unipi.gr

Abstract

Eleven box core sediments collected from various sites of the Messiniakos gulf (SW Peloponnese, Greece) were analyzed for the determination of the environmentally mobile fraction of Mn, Cd, Cr, Cu, Ni, Pb, Zn, As. More significant inter-element correlation coefficients are presented. Enrichment factors were below 1 except of Pb (r_{ef} =2.6) and Mn (r_{ef} =1) at the central part of the gulf. Total enrichment values being much below 1 reveal a low degree of metal pollution.

Keywords: Metals, Pollution, Sediments

Messiniakos gulf is located in the SW Peloponnese (Greece). Its seabed is dominated by very abrupt inclinations with depths often higher than 1000 m, resulting in extensive landslips and sediment transport. Eleven box cores were collected from various sampling sites of the gulf and divided into two sections each, corresponding to 0-5 (top, T) and 20-25 (bottom, B) cm depth. All samples were subjected to acid dissolution using microwave heating with a suitable laboratory microwave unit, applying the method EPA3051 [1]. All digests produced were analyzed using ICP-MS for the determination of the fraction of metals Mn, Cd, Cr, Cu, Ni, Pb, Zn, As [2] considered as mobile in the environment. This method does not accomplish total decomposition of the samples and therefore a few refractory sample matrix compounds may not be dissolved. However, it was applied as it deals with the non-residual metal fraction that participates in most aqueous transport mechanism of pollution, and consequently it is a good indicator of the metal biological availability. Minimum, maximum and mean values for top and bottom sections are presented in Table 1.

Tab. 1. Min, Max and Mean values (μg/g) of the environmentally mobile metal fraction

		Mn	Cd	Cr	Cu	Ni	Pb	Zn	As
T	Min	189	0.7	21.8	4.5	15.4	4.4	7.6	5.8
T	Max	1518	3.0	77.8	43.4	81.7	48.3	74.6	24.6
T	Mean	564	2.3	53.8	25.1	50.7	17.1	48.5	12.9
B	Min	207	1.5	40.8	19.5	28.9	11.0	35.1	8.4
B	Max	3368	3.2	104.2	57.4	124.9	17.4	79.0	18.6
B	Mean	760	2.5	68.9	35.9	69.9	13.7	61.1	11.7

Studying the inter-element correlation coefficients at the two sets of data (top and bottom sections), it was found that there is strong correlation (>0.8) for the pairs (Cr,Ni), (Cd,Zn), (Cu,Zn), (Cu,Ni) (Cr,Cu), (Cd,Cu), (Cr,Zn), (Ni,Zn), (Pb,Mn) (Cd,Ni), (Cd,Cr). The same applies for (Cu,Pb) at the top section and (Mn,As) at the bottom one. In a following step, enrichment factors (r_{ef}) were calculated for the eleven top sediment samples by applying the formula

$$r_{ef} = (C_{sed} - C_{back})/C_{back}$$

where, C_{sed} is the content of a metal in each surface sediment sample and C_{back} is the mean content of the same metal for all bottom sediment samples [3]. The enrichment factors were below 1 except of Pb (ref =2.6) and Mn (r_{ef} =1) at the central part of the gulf. Lead is a good indicator of urban metal pollution and can be used for the estimation of the relative pollution in surface sediments. Total enrichment factor values R, defined as R=(Σ ref)/n, were much below 1, revealing a low degree of metal pollution.

References

1 - EPA Method 3051A, 1998. Microwave assisted acid digestion of sediments, sludges, soils and oils. http://www.epa.gov/epaoswer/hazwaste/test/pdfs/*3051* A.pdf.

2 - Sakellariadou, F., 2009. Preliminary geochemical studies in Messiniakos gulf sediments (SW Peloponnese). In: *Proceedings of the 9th Hellenic Symposium on Oceanography and Fisheries*, 266-271.

3 - Adami, G., Barbieri, P. and Reisenhofer, E. 2000. An improved index for monitoring metal pollutants in surface sediments. *Toxicological and Environmental Chemistry*, 77: 189-197.

DOC EXPORT BELOW THE MIXED LAYER IN THE SOUTHERN ADRIATIC SEA

C. Santinelli [1]*, M. Ribera D'Alcalà [2], G. Civitarese [3], R. Lavezza [1] and A. Seritti [1]
[1] CNR, Istituto di Biofisica, Pisa, Italy - chiara.santinelli@pi.ibf.cnr.it
[2] Stazione Zoologica "A. Dhorn", Napoli, Italy
[3] OGS, Trieste, Italy

Abstract

DOC data collected in the Southern Adriatic Sea in three different seasons showed that the physical processes (thermocline, water masses circulation, deep water formation) strongly affected DOC distribution. In the surface layer (0-200 m) a clear seasonality was observed and it was mainly due to the occurrence of the thermocline. When the thermocline breaks the DOC accumulated in summer is transported below the mixed layer, from these data we can roughly estimate that the C export through this process is comparable to the export of POC.

Keywords: Carbon, Adriatic Sea, Deep Sea Processes, Organic Matter

Dissolved organic carbon (DOC) represents the largest, the most complex and the less understood reservoir of organic carbon on the Earth. The difficulty to describe and quantify marine DOC dynamics and cycles is due to the very scarce information on its numerous sources and sinks and to its variable and unknown composition. Although the bulk of DOC represents a continuum of biological lability, three fractions have been defined in the Ocean [1]: (1) a labile fraction, with a turnover time of minutes to days; (2) a semi-labile fraction, with turnover time of months to years; and (3) a refractory fraction, with a turn over time of centuries to millennia. DOC concentrations in oceanic waters are mainly the result of biological activity, whereas its distribution is driven by water mass circulation [2], such as has been previously reported for the Mediterranean Sea [3, 4, 5]. DOC data were collected in 9 stations, along the whole water column, in fall (November 2006), winter (February 2007) and spring (April 2007) (Fig.1), in the framework of the Italian Project "VECTOR" in the southern Adriatic Sea, an important site of deep water formation for the whole Eastern Mediterranean Sea. Main goals of this work were: (i) to evaluate the seasonal variability of DOC; (ii) to assess the processes mainly driving DOC distribution; (v) to estimate the role of DOM in carbon export at depth.

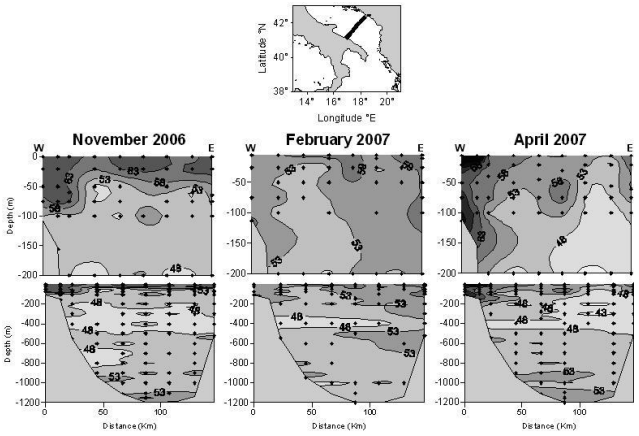


Fig. 1. DOC (mM) distribution along a section in the Southern Adriatic Sea (see the inset map), in three different periods.

In general DOC showed highly variable values (50-80 uM**)** in the surface layer (0-100 m), a decreasing until values of 42-48 uM at 300-500 m and concentrations ranging from 50 to 60 uM in the deep waters. In all the stations, the highest DOC values (> 63 uM) were observed in the mixed layer (< 50 m) after the summer, when the water column was well stratified (November 2006). In contrast, in winter, when the water column was mixed, almost homogeneous values were found until 200 m depth, without accumulation in the surface layer. These data suggest that the physical processes (thermocline, water masses circulation, deep water formation) strongly affected DOC distribution. In the surface layer (0-200 m) a clear seasonality was observed and it was mainly due to the occurrence of the thermocline. When the thermocline breaks the DOC accumulated in summer is transported below the mixed layer, from these data we can roughly estimate that the C export through this process is comparable to the export of POC. Considering the intermediate waters, in all the periods, DOC showed a minimum (42-48 uM) in the core of the Levantine intermediate water (LIW), recognizable by its salinity maximum (>38.77) and its oxygen minimum (<210 uM). In contrast, the deep waters were characterized by an increase in DOC (>53 uM). This increase was attributed to the occurrence of young waters, recently ventilated (DO>228 uM). This water may be advected from the northern Adriatic sea or it may be formed by deep convection in the central part of the section. Assuming that the concentration of the refractory fraction of DOC in the Mediterranean Sea is 40 uM (like in the Ocean), in the LIW the semi-labile DOC should account for only the 5% to 17%. In contrast, in the young deep water, the high DOC concentration suggests the occurrence of a semi-labile fraction of DOC higher than 10 mM, this is transported at depth during deep water formation and it is not yet consumed. These data indicate that the deep waters should contain an high percentage of semi-labile DOC (20-33%). This could represent a very important source of energy for deep sea ecosystem.

References

1 - Carlson C.A., 2002. Production and removal processes. In: Hansell D.A., Carlson C.A., (Eds.), Biogeochemistry of Marine Dissolved Organic Matter. Elsevier, San Diego, pp. 91-151.

2 - Hansell D.A., 2002. DOC in the global ocean carbon cycle. In: Hansell D.A., Carlson C.A., (Eds.), Biogeochemistry of Marine Dissolved Organic Matter. Elsevier, San Diego, pp. 685-715.

3 - Seritti A., Manca B.B., Santinelli C., Murru E., Boldrin A., Nannicini,L., 2003. Relationships between dissolved organic carbon (DOC) and watermass structures in the Ionian Sea (winter 1999). *Journal of Geophysical Research* 108 (C9), 8112. doi:10.1029/2002JC001345.

4 - Santinelli C., Manca B.B., Gasparini G.P., Nannicini L., Seritti A., 2006. Vertical distribution of dissolved organic carbon (DOC) in the Mediterranean Sea. *Climate Research* 31, 205-216.

5 - Santinelli C., Ribotti A., Sorgente R., Gasparini G.P., Nannicini L., Vignudelli S., Seritti A., 2008. Coastal dynamics and dissolved organic carbon in the western Sardinian shelf (Western Mediterranean). *Journal of Marine Systems* 74, 167-188.

SPATIAL DISTRIBUTIONS OF NUTRIENTS IN THE NORTH EAST MEDITERRANEAN DURING 2008 – 2009

Fatih Sert [1]* and Süleyman Tugrul [1]
[1] Middle East Technical University, Institute of Marine Sciences - fsert@ims.metu.edu.tr

Abstract
North Eastern Mediterranen waters has been surveyed as two distinct basin in Turkish coasts in 2008 – 2009 period. Including Mersin Bay, Cilician Basin were examined with several cruises between March 2008 and October 2009. Moreover, we visited 10 stations (20 miles apart) on a south-north transect in Levantine Sea in March and September 2008. These studies aimed to assess spatial distributions of principal hydro-chemical properties (nutrients, DO, Chl-a) of these two basin with surface distribution and depth profiles.
Keywords: Nutrients, Levantine Basin, Oxygen, Chlorophyll-a, Eastern Mediterranean

The Cilicain basin of oligotrophic NE Mediterranean has a wide and shallow shef zone, so-called Mersin Bay receiving discharges of polluted rivers (Berdan and Seyhan) and domestic wastewaters of Mersin city [1],[2]. In order to sound understand hydrochemical dynamics of Cilician shelf zone, seasonal cruises were carried out between September 2008 and August 2009. Pre-defined stations on the shelf were visited for measurements of CTD, dissolved inorganic nutrient, total-P, DO, and chl-a concentrations. In September, when the upper layer was thermally stratified and river discharges remained at minimal levels, dissolved inorganic nutrient concentrations were very low in offshore zone of the basin. However, markedly high values of nutrients and Chl-a were recorded in the nearshore waters fed by the rivers. In the winter period, when the upper layer was well mixed and flushed by open sea, nitrate was at levels of 15 – 20 µM in near shore waters; it decreased to levels of 0.1-0.2 levels in the offshore waters. Surface PO_4 concentrations ranged between 0.02 and 0.4 µM, with the largest values in the nitrate and silicate-replete nearshore waters. Total phosphorus (TP) concentrations displayed a similar trend, decreasing from 0.4 µM level to 0.08 µM in the offshore. High TP/PO_4 molar ratios (10-12) demonstrate that TP pool in the upper layer is dominated by organic P in the shelf zone. In summer of 2009, Chl-a concentration ranged regionally from 0.05-0.1 µg/L levels in offshore to 2.5 – 3.0 µg/L in the coastal waters of the bay. The NO_3/PO_4 (N/P) ratio was apparently high in the nearshore waters fed by nitrate and silicate rich river waters. The offshore N/P ratio declined to levels of 5 – 10 in the studied periods. However, surface Si/NO_3 ratios ranged between 0.5 – 1.0 in coastal waters of the Cilician basin, whereas the offshore ratio values were in the range of 5 – 8 for 2008-2009. DO concentration in shelf water exceeded the saturation values by up to 10-30% in the eutrophic nearshore zone having markedly high Chl-a values and low water transparency.

The SESAME cruises were carried out in the Cilician and Levantine basins of NE Mediterranean, in March and September 2008. In Cilician basin, relatively higher NO_3 and Si and TP were recorded in the nearshore waters receiving discharges of nutrient-rich rivers and domestic wastes of Mersin city. Surface TP values steadily declined from 0.4 – 0.5 µM in the productive nearshore zone to levels of 0.08-0.10 µM in the offshore water colum. A similar spatial pattern was seen in nitrate and phosphate values and also in the N/P ratio. The N/P ratio in P-depleted offshore waters could be underestimated because PO4 values could be below the detection of the method (nearly 0.02 µM). The Levantine deep water contained 5-6.5 µM of nitrate and 0.18 - 0.22 µM of PO_4 below 350-400 m, with N/P ratios of 35 - 40. TP values increased from 0.1 – 0.12 µM in the upper layer to 0.25 – 0.30 µM levels in the deep layer. It appears that the TP pool in the deep layer was dominated by PO_4, whereas organic-P was the major fraction of TP in the upper layer. Surface silicate concentrations were lower in October-08 than in April-08; however, the euphotic zone values generally varied between 1.0-2.0 µM in the upper layer water, increasing up to 10-11 µM levels below 500 m. In the DO-saturated upper layer, Chl-a was relatively low (0.03-0.20 µg/L) in the near-surface waters, displaying its characteristic deep maximum (DCM) below 75m. DO declined to levels of 170 – 190 µM in deep layer. POM concentrations were as low as 2 – 4 µM for POC and 0.3 - 0.5 µM for PON in the euphotic zone of the oligotrophic NE Mediterranean. However; POC/PON ratio ranged merely between 6 and 8 in the water column.

References
1 - TUGRUL S., Yemenicioglu S., Ediger D., Uysal Z., Mutlu E., Dogan-Saglamtimur N., Yilmaz D., Devrimci H. A.., 2005. Med Poll Phase III Long Term Bio Monitoring Trend Monitoring, Compliance Monitoring and Eutrofication Monitoring Program in Coastal and Hot Spot Areas from Northeastern Mediterranean Final Report 2005, Ministry of Environment and Forestry Turkey, Pp: 336.

2 - YILMAZ A., Bastürk Ö., Saydam C., Ediger D., Yilmaz, K., Hatipoglu, E., 1992. Eutrophication in Iskenderun Bay, Northeastern Mediterranean. Sci. Tot. Environ. (Special Issue). In: Marine Coastal Eutrophication (Vollenweider, R.A., Marchetti, R., Viviani, R., eds.) Elsevier, Amsterdam, pp: 705-717.

TOTAL INORGANIC CARBON AND TOTAL ALKALINITY DISTRIBUTION IN THE AEGEAN SEA

Ekaterini Souvermezoglou [1]*, Evangelia Krasakopoulou [1] and Catherine Goyet [2]
[1] Institute of Oceanography, Hellenic Centre for Marine Research - katerina@ath.hcmr.gr
[2] IMAGES, Universite de Perpignan

Abstract
Data of C_T and A_T were obtained in the Eastern Mediterranean in the frame of SESAME project. Preliminary results showed that Aegean Sea deep waters have the highest concentrations in C_T and A_T. Important differences on the concentrations of these two parameters, observed in the deep waters of the North and South Aegean during spring 2008 can be attributed to the dense water formation in the North Aegean Sea.
Keywords: Aegean Sea, Eastern Mediterranean, Carbon, Oxygen

Introduction
Total Inorganic Carbon (C_T) and Total Alkalinity (A_T) were determined in seawater samples collected in the Eastern Mediterranean (Aegean- Ionian-Levantine) during two cruises performed in the framework of the SESAME project during spring and late summer 2008, in order to provide both knowledge and reference for further investigation on the carbonate system.
The carbon dioxide system in the Eastern Mediterranean is very poorly studied. C_T and alkalinity values have been obtained at the 404 Geosecs station [1]. In 1983, [2] presented oxygen, C_T and phosphate correlation in two stations in Central and South Adriatic waters. The distribution of C_T and its relation with oxygen and nutrients in a dense grid of stations in the Northern Adriatic Sea were presented by [3]. Recently [4] published C_T and A_T data collected in Thermaikos Gulf (NW Aegean) in May 1997.

Results & Discussion
Preliminary results of the distributions of these two parameters in the Eastern Mediterranean, showed that the Aegean Sea deep waters have the highest C_T and A_T, reaching 2340 and 2670 mmol kg^{-1} respectively. Nevertheless our results revealed important differences between the North and the South Aegean Sea. In the surface layer the higher C_T, A_T and oxygen values were recorded in northernmost part of the Aegean Sea in the 'less warm' and 'less saline' surface water of Black Sea origin (Figs. 1 & 2).

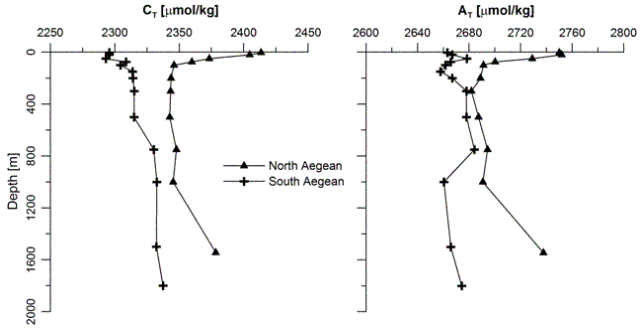


Fig. 1. Vertical distribution of C_T and A_T (μmol/kg) in the Northern and the Southern Aegean Sea

Our observations support the hypothesis of the major influence of the Black Sea to the Mediterranean water alkalinity, argued recently by some authors [5]. During spring 2008, the deep waters of the North Aegean Sea are richer in both C_T and A_T regarding those of the South Aegean Sea, indicating the existence of different sources of deep water and the limited communication between the two basins.
Indeed, the bottom topography of the region is characterised by an alternation of plateaux and deep troughs allowing water exchange above 400-m depth. Below 400 m, the deep basins of the North Aegean are filled with very dense water of local origin [6] and the deep basin of the South Aegean with Cretan Deep Water [7].
The C_T and A_T concentrations of the North Aegean Sea intermediate layer, reach the concentrations of the deep waters of the South Aegean Sea and the deep waters of the North Aegean are very well oxygenated (Fig. 2). Further examination of the oxygen distributions and the T-S diagrams showed that a dense water formation event occurred in North Aegean during winter 2008.

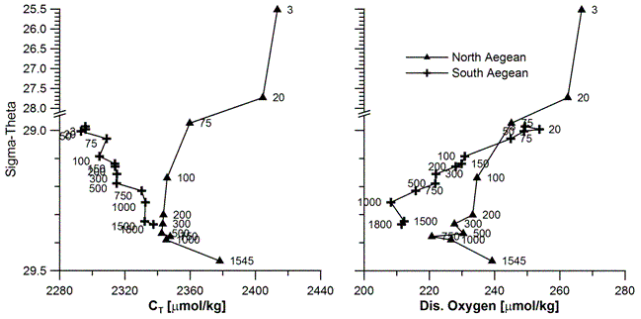


Fig. 2. Distribution of C_T and dissolved oxygen (μmol/kg) plotted against sigma-theta in the Northern and the Southern Aegean Sea

References
1 - Bradshaw, A.C., Brewer, P.G., Shafer, D.K. and Williams, R.T., 1981. Carbon dioxide and alkalinity by potentiometric titration in the GEOSECS program. *Earth Planet. Sci. Lett.*, 55 : 99-115.
2 - Vukadin, I. and Stojanoski, L., 1983. Oxygen - total carbon dioxide - phosphate correlation in the Adriatic waters. Rapp. Comm. int. Mer Medit., 28, 7.
3 - Souvermezoglou, E. and Krasakopoulou, E., 1999. Sources and sinks of dissolved inorganic carbon (TCO_2) in the Northern and Middle Adriatic Sea. In: Hopkins, Artegiani, Cauwet, Degobbis, Malej (eds) Ecosystems Research Report Series No 32 - The Adriatic Sea, EU/Environment, Brussels, 215-223.
4 - Krasakopoulou, E., Anagnostou, Ch., Souvermezoglou, E., Papathanassiou, E. and Rapsomanikis S., 2006. Distribution of dissolved inorganic carbon and related parameters in the Thermaikos Gulf (Eastern Mediterranean). *Medit. Mar. Sci.*, 7/1, 63-78.
5 - Schneider A., Wallace D. W. R. and Kortzinger A. 2007. Alkalinity of the Mediterranean Sea. *Geophys. Res. Lett.*, 34, L15608, doi : 10,1029/2006GL028842.
6 - Zervakis V., Georgopoulos D., Drakopoulos P. G., 2000. The role of the North Aegean in triggering the recent Eastern Mediterranean climatic changes. *J. Geophys. Res.* 105 (C11), 26103-26116.
7 - Theoharis A., Balopoulos E., Kioroglou S., Kontoyiannis H. and Iona A., 1999. A synthesis of the circulationand hydrography of the South Aegean Sea and the straits of the Cretan Arc. *Prog. Oceanogr.* 44, 469-509.

STUDY OF THE SPATIAL AND HISTORICAL DISTRIBUTION OF SEDIMENT INORGANIC AND ORGANIC CONTAMINATION IN THE TOULON BAY (FRANCE)

E. Tessier [1]*, C. Garnier [1], G. Durrieu [1], D. François [2], V. Lenoble [1], G. Tua [2], J. U. Mullot [2], D. Cossa [3], M. Arnaud [4] and S. Mounier [1]

[1] Laboratoire PROTEE, Université du Sud Toulon Var, BP20132 83957 La Garde, France - tessier@univ-tln.fr

[2] LASEM, Base Navale de Toulon, BP 61, 83800 Toulon, France

[3] IFREMER, Département Biogéochimie et Ecotoxicologie, B.P.330 Zone Portuaire de Brégaillon, 83507 La Seyne/mer cedex, France

[4] IRSN, Laboratoire d'Etudes Radioécologiques du milieu Continental et Marin, Base Ifremer, BP 330, 83507 La Seyne/mer cedex, France

Abstract

The Toulon bay (France), situated in the north-western part of the Mediterranean sea, was the object of an intensive investigation of its sediment contamination, in the framework of a multi-partners collaborative project. Surface and deep sediment sampling campaigns were performed, covering the whole Bay with spatial and deep resolutions allowing a very fine cartography. The obtained results attest its strong contamination, particularly in the small part of the Bay, were the water residence time is the longest with historic nautical activities and their associated pollutions (ex. antifouling paint release). For some pollutants, the measured values are in the order of the highest values recorded by the scientific community in the world. Study of deep sediment cores will allow investigating the history of these contamination episodes.

Keywords: Analytical Methods, Chemical Speciation, Metals, Sediments, Coastal Systems

Experimental

The Toulon bay is a semi-closed Mediterranean area, separated in two non-equal parts by a sea wall, submitted to various anthropogenic inputs, in particular to nautical activities (marina, industry, Navy). Because of this separation and the absence of regular freshwater inputs, associated to low tide, circulation of water in the small part of the bay is weak, leading to low water regeneration and so a possibly high contaminant accumulation in sediments. To map the surface contamination of this specific environment, sediments were sampled in the whole bay and chemically analysed for physico-chemical parameters, and metals, organic pollutants and radioactive elements. The first sampling strategy was dedicated to surface sediment, by specifically sampling the water/sediment interface, followed by a second sampling campaign aiming at defining the history of the sediment contamination. Surface sediment sampling campaigns were performed in November 2008, February and June 2009, with the help of French Navy boat and material, allowing the sampling of surface sediment cores (1m, in duplicate), preserving the water/sediment interface integrity. 50 points were sampled (Fig.1), covering the entire bay. Remaining water in the upper part of sediment cores was filtered and analysed to determine dissolved organic carbon (DOC) and dissolved metal (DPASV) concentrations of the water column. For each point, both sampled cores were sliced (0-5 and 5-10cm), pooled, frozen, freeze-dried, and sieved (2 mm). The obtained sediments were analysed to determine the following parameters: water content, granulometry (laser), organic and inorganic carbon contents (TOC-meter), metal/metalloid (acidic extraction under micro-wave, GFAAS) and mercury (combustion, AAS) levels.

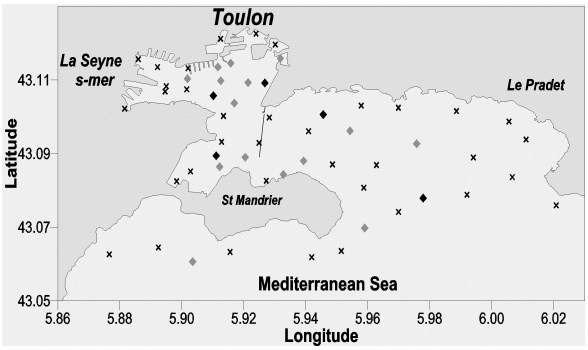


Fig. 1. Location of the sampling points (cross: 1-m interface cores only; diamond: 1-m interface and 5-m Küllenberg cores, gray and black symbols: low/medium and high resolution respectively)

A fourth sampling campaign was performed in October/November 2009, using the BeauTemps BeauPré oceanographic boat from the French Navy, allowing the sampling of deep sediments by the way of a 5m-Küllenberg corer. 20 points were sampled (Fig.1). The obtained cores were sliced depending on the defined resolution: each 10, 20 or 50 cm respectively for the High, Medium or Low Resolution points. Additionally, at the HR points, 4 interface cores were also sampled. The first 2 were used for sedimentation dating (sliced each 2 cm) and pH/Eh measurements. The 2 other were treated as follow: slicing each 2 cm (under nitrogen conditions), pooling, interstitial water extraction by centrifugation, sediment freezing, freeze-dried, and sieving (2 mm). The obtained sediments were analysed as samples originating from the surface sediment sampling campaigns. On interstitial waters, the following analyses were performed: DOC, 3-D spectroscopic fluorescence, total dissolved metal concentration (DPASV) and metal speciation (pseudo-polarography).

Results and discussion

DOC values of water column are quite homogeneous (0.9-1.2 mgC L^{-1}) in the entire bay, contrary to total dissolved metal concentrations which showed marked contamination in the small bay, particularly for Cu near the different harbours due to antifouling paint release (concentrations as high as 85 nM in the Toulon harbour). So, it can be suspected that the dissolved organic ligands will not be in sufficient concentration to maintain the free metal concentrations below the toxicity limit in the water column (ex. 10^{-11} M for Cu^{2+} [1]). Eh sediment depth profiles attests that sediments are under anoxic state from the first cm. Metallic contamination of surface sediments shows dramatically high levels, above the N2 level (French legislation on marine and estuarine sediment dredging [2], N2 levels for As, Cd, Cr, Cu, Hg, Ni, Pb and Zn respectively: 50, 2.4, 180, 90, 0.8, 74, 200 and 552 µg/g dw) by some order of magnitude, especially for the most enclosed parts of the small bay, where the water residence time are longer associated to strong nautical activities. It has to be pointed out that some specific points in the second part of the bay, directly open to the Mediterranean Sea, are also markedly polluted, signature of past anthropogenic activities and/or water circulation. Measurements on the Küllenberg cores will give information on the history of these different contaminations. Associated to measurements on interstitial water, such information will allow a better understanding of the contaminant behaviour at the water/sediment interface, influenced by diagenetic processes, which could partly control the contaminant remobilisation at the interface. This study will be completed by remobilisation experiments aiming at defining the possible contaminant remobilisation in natural events (ex. storm) or anthropogenic ones (ex. dredging) [3].

References

1 - Sunda, W.G., Tester, P.A., Huntsman, S.A.,1987. Effects of cupric and zinc ion activities on the survival and reproduction of marine copepods. *Mar. Biol.*, 94: 203–210

2 - Arrêté du 14 juin 2000 relatif aux niveaux de référence à prendre en compte lors d'une analyse de sédiments marins ou estuariens présents en milieu naturel ou portuaire. *JORF* 184: 12415-12416

3 - Saulnier, I., Mucci, A., 2000. Trace metal remobilization following the resuspension of estuarine sediments: Saguenay Fjord, Canada. *Applied Geochem.* 15: 191-210

POLYCYCLIC AROMATIC HYDROCARBONS IN THE AREA OF A GREEK PETROLEUM REFINERY

Styliani Triantafyllaki [1], Emmanouel Dassenakis [1]*, Vasiliki Paraskevopoulou [1] and Nikos Giannikopoulos [1]
[1] Laboratory of Environmental Chemistry, Faculty of Chemistry, University of Athens, Panepistimioupoli 15771, Athens, Greece - edasenak@chem.uoa.gr

Abstract
Polycyclic aromatic hydrocarbons (PAHs) in coastal areas commonly originate from petroleum extraction, transport and refining processes. They may pose a risk to marine life, as they can be both carcinogenic and mutagenic.
In this study, the 16 PAHs on the EPA's priority pollutant list were determined in the wastewater of the petroleum refinery of Motoroil Hellas, as well as in the seawater of the nearby area.
Keywords: Pah, Aegean Sea, Petroleum, Coastal Waters

Introduction
The main sources of PAHs in the environment are natural and intentional combustion of organic matter and petroleum manipulation (extraction, transport and refining) [1]. Solid phase extraction (SPE) [2] and ultrasonic extraction [3,4] are frequently used for the pre-concentration of PAHs from environmental matrices, while high performance liquid chromatography (HPLC) is often used for the analytical determination of PAHs [2,3,4]. Motoroil Hellas, an important Greek refinery, is located on the NW coast of Saronikos Gulf, about 80 km from Athens. In this study, the 16 PAHs on the EPA's priority pollutant list were determined in the treated industrial effluent (IE), sewage effluent (SE), cooling waters (CW) of the refinery, as well as in the seawater of the nearby area (stations S1, S2, S3).

Methodology
The samples were collected in March and September 2007. They were filtered using glass fibre filters within a few hours of sampling for the separation of the aqueous and the particulate matter fractions. The filtered water samples were pre-concentrated by SPE using C18 cartridges. The filters were solvent extracted using an ultrasonic bath and SPE cleanup was performed. An internal standard was added to all samples before their respective extraction techniques. After elution from the cartridges and final concentration by nitrogen blow-down, the PAHs were determined by HPLC with photo-diode array and fluorescence detectors. Gradient elution was used, as well as fluorescence wavelength programming. The only PAH not determined with the fluorescence detector was acenaphthylene, which has a fluorescence close to zero.

Results
Some determined PAH concentrations for both sampling periods are given in the tables below:

Tab. 1. PAH concentrations

March 2007						
Σ(water+part.matter)	S1	S2	S3	IE	SE	CW
naphthalene	19.5	19,0	<LD	88.5	20.3	<LD
phenanthrene	24.6	25.4	21,0	73.8	11,0	<LD
fluoranthene	7.0	5.3	4.9	59.7	<LD	<LD
pyrene	8.0	7.0	24.0	4.7	9.0	<LD
benzo(b)fluoranthene	<LD	3.8	<LD	18.8	<LD	<LD
benzo(k)fluoranthene	<LD	<LD	<LD	<LD	<LD	<LD
dibenz(a,h)anthracene	<LD	<LD	<LD	24.1	<LD	<LD
September 2007						
Σ(water+part.matter)	S1	S2	S3	IE	SE	CW
naphthalene	<LD	<LD	20.8	79.3	<LD	<LD
phenanthrene	18.9	13.6	18.6	62.4	16.5	8.4
fluoranthene	7.7	6.9	<LD	6.0	<LD	6.3
pyrene	13.6	25.9	5.3	15.0	5.4	<LD
benzo(b)fluoranthene	<LD	<LD	<LD	10.6	<LD	<LD
benzo(k)fluoranthene	<LD	<LD	<LD	3.9	<LD	<LD
dibenz(a,h)anthracene	<LD	<LD	<LD	9.0	<LD	<LD

Discussion
Individual PAH concentrations in the filtered water samples ranged from 2.9 ng/L for fluoranthene to 29.1 ng/L for phenanthrene, while in the particulate matter they ranged from 3.8 ng/L for benzo(b)fluoranthene to 88.5 ng/L for naphthalene. Two- to four-ring PAHs were more abundant; the highest concentrations were found for naphthalene (88.5 ng/L), phenanthrene (73.8 ng/L) and fluoranthene (56.8 ng/L) respectively in the particulate matter of the industrial effluent. Five- and six-ring PAHs were only detected in the particulate matter; the highest concentrations were found for dibenz(a,h) anthracene (24.1 ng/L) and benzo(b)fluoranthene (18.8 ng/L) respectively in the industrial effluent. The concentrations of individual PAHs as well as total PAHs for March in the seawater samples were overall slightly higher than those determined for September. Although concentrations of individual PAHs were generally low, it is essential to continue environmental monitoring in the area on a regular basis.

Acknowledgments: This paper is part of the 03ED186 research project (PENED), co-financed by E.U.-European Social Fund (75%) and the Greek Ministry of Development-GSRT (25%).

References
1 - UNEP, 2002. Regionally Based Assessment of Persistent Toxic Substances, Mediterranean Regional Report, UNEP Chemicals, Switzerland.
2 - Triantafyllaki S., Dassenakis M. and Psaroudakis N., 2005. Determination of Polycyclic Aromatic Hydrocarbons in Seawater by High Performance Liquid Chromatography with Photo Diode Array and Fluorescence Detection, *CEST: 9th Int. Conf. on Env. Sc. and Tech.*, 1-3/9/2005, Rhodes.
3 - Fan S.-L., Zhao L. and Lin J.-M., 2007. Flocculation-ultrasonic assisted extraction and solid phase clean-up for determination of polycyclic aromatic hydrocarbons in water rich in colloidal particulate with high performance liquid chromatography and ultraviolet-fluorescence detection, *Talanta*, 72: 1618-1624.
4 - Sun F., Littlejohn D. and Gibson M.D., 1998. Ultrasonication extraction and solid phase extraction clean-up for determination of US EPA 16 priority pollutant polycyclic aromatic hydrocarbons in soils by reversed-phase liquid chromatography with ultraviolet absorption detection, *Anal. Chim. Acta*, 364: 1-11.

CONTAMINATION OF LEBANON COAST BY POLYCYCLIC AROMATIC HYDROCARBONS AFTER JIYEH OIL SPILL IN 2006: THREE YEARS STUDY

J. Tronczynski [1], S. Azoury [1]*, K. Nakhlé [2], G. Khalaf [2] and B. Andral [1]
[1] IFREMER - Sabine.Azoury@ifremer.fr
[2] CNRSL

Abstract

The bombardment in July 2006 of the fuel tanks of the electric power plant in Jiyeh by the Israel military resulted in a major oil spill, polluting about 120 km of the Lebanon shoreline, as far as the border with Syria. The spillage estimates vary from more than 10,000 tonnes to almost 20,000 tonnes of heavy fuel oil released into the Eastern Mediterranean Sea [1, 2]. The prevailing currents, water masses circulation and wind trajectories in July 2006, favored oil slicks transport to the north from the Jiyeh plant. We report here an assessment into the chemical contamination of marine organisms (fish and shellfish) resulting from this oil spillage, as a complimentary part of scientific surveys carried out for the evaluation of the ecological consequences of this oil spill.

Keywords: Petroleum, Pah, Mollusca, Bio-Indicators

Materials and methods

The intertidal mussel (*Brachidontes variabilis*) samples were taken in October 2006, in May 2007 and in April 2008 at 9 sampling stations along Lebanon coast, from the south (Itanieh, 33°21'298 N 35°14'846 E) up to the north, near the Syrian border (Qlaiaat, 34°35'663 N, 35°59'269 E). The temporal survey started in August 2006, and several mussel samples have been collected since that time in Batroun (northern coast). Caged mussels were also moored for three months in the water column at four Lebanon stations and three Syria stations in 2007. About 300 specimens of controlled shell sizes were pooled as a composite sample representative of each sampling location. Shellfish sampling was performed so as to avoid any contamination by coated fuel. The GC-MS analysis made it possible to identify and quantify parent unsubstituted PAHs, alkyl-substituted PAHs (C-PAH) and sulfur heterocycle unsubstituted and alkyl substituted compounds (SPAH and C-SPAH). Multivariate analysis and receptor modeling were applied for a better identification and apportionment PAHs originating from Jiyeh fuel oil in the mussel samples from the Lebanon coast.

Results and discussion

The spatial and temporal changes in the compositional patterns of PAHs and their levels in the intertidal mussel samples after the Jiyeh oil spill are reported. It appears that in October 2006 all intertidal mollusks sampled along the Lebanon coast north to the Jiyeh power plant were heavily contaminated by PAHs from Jiyeh fuel oil, and that this contamination extends at least to the Syrian border. This is clearly demonstrated by the increase in the concentration levels and by the drastic change in the distribution pattern of compounds in the shellfish inhabiting the northern part of Lebanon, compared to the mussel samples from the south. Furthermore, the strong spatial gradients in PAH concentrations in intertidal mollusks matches the extent of the shoreline contamination by the spilled fuel revealed by satellite images. Whereas PAH concentrations in the mussels from southern Lebanon (station Itanieh) are indeed very low and do not show, either by their levels or by their chemical fingerprints any significant contamination by PAHs from Jiyeh fuel oil. At that time, in October 2006, in this area, there were no visible traces of the spilled oil, and mussel samples collected south of the power plant probably came from an area outside of the influence of the oil spill. Indeed, the prevailing currents, water masses circulation and wind trajectories in July 2006 favored oil slicks transport to the north, away from the Jiyeh plant. The levels of PAHs found in caged mussels deployed offshore, in the water column, between May and August 2007 were also significantly lower than levels determined in the samples in intertidal mollusks. These results, as well as strong spatial gradients between stations, suggest probably weaker sub-tidal and benthic habitats contamination by PAHs from Jiyeh fuel. Furthermore, the concentrations of PAHs in subtidal oysters (*Ostrea edulis*) from Lebanon coast, reported elsewhere [3, 4], are definitely lower than PAH levels in the intertidal mussel samples. Consistent temporal decline (2006 to 2009) in PAH concentrations in intertidal shellfish were also distinguished, however in heavily contaminated locations such as Jiyeh and Byblos chemical fingerprints were still characteristic of Jiyeh oil induced contamination even three years after the disaster. Finally, in order to better scale the PAH levels and patterns determined in the mussels after the Jiyeh oil spill, the results were also compared with PAH data in mussels (*Mytilus galloprovincialis*) collected in the Western Mediterranean along the coast of France. These later data were obtained within routine chemical monitoring and provide external reference for the PAH chronic contamination in the Western Mediterranean Sea.

In conclusion, the PAH data in the intertidal mollusks from Lebanon represent both sensitive and accurate qualitative and quantitative indicator of the environmental impacts of the Jiyeh oil spill along the Lebanon coast.

References

1 - MoE Ministry of the environment., 2006., Oil spill along the Lebanese coastline: presentation of the ministry of environment. Press Union. July. Beirut-Lebanon.

2 - UNDP/MoE,. 2007. Oil spill underwater survey : final report, prepared by Sabine Ghosan and Marcos Hado. UNEP/Lebanon MoE. p17.

3 - UNEP., 2007. Lebanon: post-conflict environmental assessment. Report DEP/0915/GE, p 184.

4 - Kelly C., Santillo D., Johnston P., Fayad G., Baker K.L., Law R.J., 2006. Polycyclic aromatic hydrocarbons in oysters from the coastal waters of Lebanon 10 months after the Jiyeh oil spill in 2006. *Mar. Pollut. Bull*., 56: 1212-1218.

LONG-TERM CHANGES IN THE HYDRO-CHEMICAL PROPERTIES OF BLACK SEA UPPER LAYER

Suleyman Tugrul [1]*, Gernot E. Friederich [2], James W Murray [3] and Ilkay Salihoglu [4]
[1] METU-IMS - tugrul@ims.metu.edu.tr
[2] School of Oceanography, University of Washington
[3] MBARI
[4] Near East University

Abstract
Long-term hydro-chemical data, including pump-cast measurements obtained during the Knorr 2001 cruise, have been evaluated to assess spatial/temporal changes in distinct hydro-chemical features, lateral intrusions of Bosphorus plume and NW shelf waters to western basin of the Black Sea. The suboxic zone, having distict chemical features, remained enlarged since 80's. The upper layer silicate stock has decreased drastically as the phosphate and nitrate displayed opposite trends since late 60's.
Keywords: Nutrients, Anoxia, Black Sea, Eutrophication

The Black Sea, a land-locked deep basin occupied with brackish waters, possesses distinctly different biochemical properties due to the presence of oxygenated in the upper layer and sulfide-bearing waters below a depth of 100-150 m and a transition zone in between [1-5]. The occurrence of hypoxia and anoxia in the Black Sea causes nutrients and other redox-sensitive elements to exhibit distinct vertical features in the Black Sea water column that are different from those profiles in the oxygenated basins of the world's oceans [1-5]. Though principal hydrochemical properties of the Black Sea system are known, spatial and temporal changes in the Black Sea and processes responsible for these variations are still poorly understood due to the lack of high-quality and high-resolution historical data and complicated biogeochemical reactions in the oxic/anoxic transition zone. Lateral and vertical oxygen influxes together with the catalytic reactions of manganese in the interface keep the sulfide-bearing waters in the deep basin at similar density surface over the basin for years [2-5]. Comparison of the new and historical data sets indicates long-term changes in Black Sea upper layer chemistry. Increasing inputs of nutrients by the polluted rivers with modified N/Si/P molar ratios have severely altered bio-chemical properties of the whole Black Sea [1-4]. Increasing load of DIN by the Danube and concurrent depletion of phosphate in the NW shelf euphotic zone and cold intermediate layer (CIL) in 80's, has led to markedly high N/P ratios in shelf waters down to CIL depths. In this period, the nitrate stock of the upper layer has increased by 2-3 times as silicate stock displayed an opposite trend in the upper layer down to onoxic intreface since the 60's [2-4]. Thus, nitrate/silicate ratio decreased drastically in the upper layer throughout the basin [4]. However, there has been a slow increasing trend in the surface silicate values in the last decade, suggesting progressive changes in the Black Sea ecosystem. It has been documented that oxygen and sulfide do not co-exist in the interface due to high rate of sulfide oxidation by oxygen [3-5].

Until the Knorr 1988 cruise, no integrated studies have been carried out in the Black Sea to provide real-time and near real-time chemical measurements and oxidation-reduction rates of redox-sensitive elements in the oxic/anoxic transition zone in the western basin. During the 2001 Knorr cruise, we have obtained high-resolution data of nutrients, dissolved manganese (and reduced iron at two stations) by both pump-profiling system and bottle-casts. The Knorr 2001 results demonstrate regional variability in vertical structures of nutrients and dissolved manganese in the western Black Sea Black Sea upper layer, depending on circulation patterns, particle influx from the surface layer and lateral intrusion of oxygen via Bosphorus plume. Lateral intrusions of partly oxygenated and nitrate-rich Bosphorus plume by mixing with cold intermediate layer (CIL) appear to ventilate and thus modify characteristic chemical structures in the oxic/anoxic transition layer of the rim current in the SW basin. Specifically, secondary broad nitrate peaks appears in the oxygen depleted transition zone, as well as to the co-existence of nitrate, ammonia, dissolved manganese and nitrite in the suboxic/anoxic interface. Silicate profiles also displayed undulating patterns with depth. Thus, the onset of sulfide-bearing water shifts to greater density surfaces by about 0.2 density units in the SW region. Moreover, small undulating patterns of nitrate profiles in the suboxic zone of the northern slope and central gyre imply weak intrusions of CIL waters from western shelf with different chemical properties. Climatic warming in recent years seems to have decreased the nitrate content of CIL waters evolved in NW shelf, which flows towards SW coastal region via rim current system.

Acknowledgements: The study was supported by Turkish Scientific and Technological Research Council (TUBITAK-TARAL; project no:107G066) and EU-6th Framework Progmamme (SESAME project).

References
1 - Sorokin Yu. I., 1983. The Black Sea. In: Estuaries and Enclosed Seas. Ecosystem of the World, B.H.Ketchum, editor. Elsevier, Amsterdam, pp. 253-291.

2 - Murray, J.W., Jannash, H.W., Honjo, S., Anderson, R.F., Reeburg, W.S., Top. Z., Friederich, G.E., Codispoti, L.A., Izdar, E., 1989. Unexpected changes in the oxic/anoxic interface in the Black Sea. *Nature*, 338, 411-413.

3 - Codispoti L.A., Friederich G.E., Murray J.W. and Samatamota C.M., 1991. Chemical variability in the Black Sea: implications of data obtained with a continuous vertical profiling system that penetrated the oxic/anoxic interface. *Deep-Sea Research*, 38(Suppl.2): 691-710.

4 - Tugrul, S., Bastürk, Ö., Saydam, C. and Yilmaz, A., 1992. Changes in the hydrochemistry of the Black Sea inferred from water density profiles. *Nature*, 359: 137-139.

5 - Konovalov S.K. and Murray J.W., 2001. Variations in the chemistry of the Black Sea on a time scale of decades (1960-1995). *Journal of Marine Systems*, 31: 217-243.

ASSESSMENT OF HEAVY METAL CONTAMINATION IN SURFACE SEDIMENTS OF THE HOMA LAGOON IN THE IZMIR BAY (EASTERN AEGEAN)

Esin Uluturhan [1]*, Aynur Kontas [1] and Elif Can [1]
[1] Dokuz Eylul University, Institute of Marine Sciences and Technology - esin.uluturhan@deu.edu.tr

Abstract
The heavy metal (Pb, Cr, Cu, Zn and Fe) concentrations in sediment were investigated in Homa Lagoon from the Izmir Bay. The surface sediments were collected from 8 stations at September 2005 - 2006. Homa Lagoon was polluted with Cr. On the contrary, Pb Cu, Zn and Fe values were smaller than those for average shale.
Keywords: Aegean Sea, Metals, Pollution, Sediments

Introduction
Marine sediments provide useful information for environmental and geochemical research about marine pollution. Urban and industrial activities contribute to the introduction of significant amounts of pollutants into the marine environment and affect directly the coastal systems where they are quite often deposited. Also, heavy metals, pesticides and other toxic substances could be absorbed from the water column onto surfaces of fine particles and usually move thereafter with the sediments [1]**.**The study area Homa Lagoon is a coastal lagoon located in the Gediz Delta where agricultural drainage, water, industrial and domestic wastewater are transported by Gediz River. The lagoon is one of the 10 most productive lagoons in the Aegean Sea.

Materials and Methods
The surface sediments were collected from 8 stations in the Homa Lagoon in September 2005-2006. Sediment samples were taken using van-Veen grab. Immediately after collection, the sediments were placed in acid cleaned polyethylene bottles and frozen (-20°C). Thereafter, samples were dried in an oven at 50°C, and then sieved to pass 63 mm and homogenized. Samples were digested in microwave digestion system (Milestone 1200) with a HNO_3-HF-$HClO_4$-HCl acid mixture solutions were analyzed by flame AAS (Varian Spectraa-300 plus), using the manufacturer's conditions and with background correction [2,3].

Results
The mean concentrations of heavy metals in sediments and the average shale values were summarized in Table 1. Comparison of the metal concentrations with average shale values revealed that most of the samples from the Homa Lagoon were polluted with Cr. On the contrary, Pb Cu, Zn and Fe values were smaller than those for average shale, which indicated that there were no major sources of pollution for these elements in the Homa Lagoon. The highest Pb, Zn and Fe were measured at station E while maximum level of Cr was found at station C. Also the Cu content was high at station B. The statistical analysis of intermetallic relationship revealed that the high degree of correlation and significant regression relation among the metals indicate the identical behavior of metals in the marine environment. Sediment Pb showed positive correlation with Zn (r=0.81), Cu (r=0.93) and Fe (r=0.87). Also, significant positive correlations were observed between Cr- Zn (r=0.55), Cr-Fe (r=0.59), Cu-Zn (r=0.83), Cu-Fe (r=0.93) and Zn-Fe (r=0.80). Those correlations are probably indicating that these elements have the same source, possibly lithologic, characteristic of sediment was non impacted and therefore, of natural origin [1].

Table1. Total metal concentrations in sediment (mean±S.D. in mg kg-1, dry weight) from Homa Lagoon and background values (BCG) [4]

St.	Pb	Cr	Cu	Zn	Fe
A	10.4±8.58	101.3±23.3	17.2±7.37	63.4±23.6	21716±6593
B	11.9±4.38	106.8±30.7	22.1±3.11	78.9±14.6	25774±5544
C	12.8±4.62	110.2±9.16	20.7±3.96	76.5±3.68	25593±4594
D	12.4±2.10	109.0±15.1	19.9±0.98	81.3±12.0	24787±1331
E	15.6±2.30	106.9±22.8	24.0±2.63	89.6±3.26	27361±4063
F	4.05±2.29	93.6±13.6	13.5±0.16	50.4±5.81	20289±1039
G	12.7±0.55	87.3±3.88	19.4±2.19	67.9±8.54	21956±443
H	3.97±0.82	105.5±3.77	11.3±1.54	60.1±18.9	18702±1273
BCG	**20**	**90**	**45**	**95**	**47000**

References
1 - Salomons, W., Fostner, V., 1984. Metals in the Hydrocycle, pp 63-93.
2 - UNEP., 1984. Determination of total Cd, Zn, Pb and Cu in selected marine organisms by flameless AAS, vol. 11.
3 - UNEP., 1986. Determination of total manganese in marine sediments by flame atomic absorption spectrophometry, No: 38.
4 - Turekian, K.K., & Wedepohl, K.H. (1961). Distribution of the elements in some major units of the earth's crust. Geological Society of American Bulletin, 72: 175-192.

HYDROCARBON CONCENTRATIONS IN SURFACE SEDIMENTS FROM AMBARLI HARBOR (SEA OF MARMARA, TURKEY)

S. Unlu [1]*, E. Sari [1], N. Ç. Balci [2], B. Koldemir [3] and R. Apak [1]
[1] Istanbul University ,Institute of Marine Science and Management - su@istanbul.edu.tr
[2] Istanbul Technical University, Department of Geology, Maslak, Istanbul, Turkey
[3] Istanbul University, Faculty of Engineering, Department of Marine Transportation and Management, Avcilar, Istanbul, Turkey

Abstract
Surface sediments collected from 33 stations along the Ambarli Harbor, the Sea of Marmara, were analyzed for petroleum aromatic hydrocarbons by UV-fluorescence. Higher concentrations of total aromatic hydrocarbons were found of all the samples collected during May 2009, with levels ranging 1860 and 72 µg/g eq oil (205 and 7 µg/g chrysene eq.). The spectra indicate dominant pyrolytic origins in some stations of pyrolysis reactions of fossil fuels where the 3-4 ring PAHs are dominant. The pyrolytic contamination of these stations could be attributed to fossil fuel oil particulates emission by commercial vessels, heavy maritime traffic, particularly involving petroleum transports and fishing boats, and the improper disposal of ballast and bilge waters.
Keywords: Petroleum, Pah, Sediments, Marmara Sea, Pollution

Introduction
Sources of contaminants in the Harbor include municipal and industrial discharges, atmospheric inputs, non-point source runoff, hazardous waste sites, landfills, combined sewer overflows and accidental spills. The important sea pollutants originated from ship and seaport are as follows: oil-products, crew-disposals (i.e., shower, sink and toilet), bilge water, ballast, washing water for ballast, liquid-, and solid type poisonous materials carried by the ships and garbage of the ships. It is known that these anthropogenic pollutants arrive at the sediments, then, negatively affect the quality of the sediment.
Ambarli Harbor in Marmara region has an important position as a seaport especially for the city of Istanbul. It serves to the ships such as container-, cargo-, RoRo- and tanker types. Analyzing of the data from 2007 shows that totally 4959 ships has made use of the seaport.
The purpose of this study was to determine the concentration of the total hydrocarbons in the surface sediments in and offshore Ambarli Harbor to provide data for comparison by different reference materials and to get understand whether pyrolytic or petrogenic inputs come from anthropogenic processes.

Material and Method
Sampling
The sediments were taken by using the grab sampler, in May 2009 on board of R/V ARAR from 33 stations. The sampling depths were between 11 and 78m. The topmost 0-5 cm of the grab sample was carefully removed using clean spatula. The samples were stored in a freezer at -20°C until analysis.
Analytical procedure
The methods used in this study have been described in detail [1] and will only be summarized here. TOC contents were measured by means of the Walkey-Black Method [2]. Extraction of samples with a Soxhlet apparatus and analyses by UV fluorescence spectroscopy (Jasco-6300, Shimadzu) were given in detail by Ünlü [1]. Considering spectrofluorometer conditions, excitation and emission wave-lengths were fixed to 310 and 360 nm for single measurement, respectively.

Results and Discussion
The TOC content of the sediment samples, which accounts for most of the variation in the uptake of contaminants by the sediment, is variable and ranges from 0.37% to 3.82%.Total aromatic hydrocarbon concentrations in samples varied between, 1860 µg/g and 72 µg/g equivalents of oil (205 µg/g and 7 µg/g chrysene eq.). An acceptable upper limit is 50 µg/g for clean sea floor sediments [3] and the concentrations higher than 100 (µg/g dry weight) are mainly related with terrestrial (riverine) inputs or port activities, on the basis of classification adapted by Readman [4]. According to fluorescence synchronous spectra of the sediment extracts containing >100 µg/g confirm the existence of a chronic oil pollution in the sampling region and suggest the presence of high potential hazards to aquatic organisms in the study area.
Although in general UV fluorescence technique has been replaced by more specific methods it is still being used for monitoring spatial and temporal concentration gradients of petroleum hydrocarbons in sediment. Because of its simplicity, sensitivity and easy application, UV fluorescence in synchronous excitation-emission technique constitutes a promising tool to be used in determination the polyaromatic structure of a compound since Lloyd has developed this method [5]. It simplifies the emission of each component of a mixture and gives a better-resolved spectrum for the whole of the mixture components [5]. According to the number of aromatic rings (spectral region from 220-700 nm), the USEPA priority PAH compounds were divided into three groups, representing two-, and three-, four-, and five-, and more ring PAHs.
Petroleum hydrocarbons in crude oil and light refined products are dominated by the lowest molecular weight PAHs with only trace levels of the penta- and hexa- aromatics present. However, 1-2 rings PAHs have not been encountered in the sediment samples. It appears likely that the more volatile PAHs are rapidly lost in this environment, through evaporation and photo-decomposition.
Our results indicate dominant pyrolytic origins in all samples with small amount of pyrolysis reactions of fossil fuels at some stations (e.g. A1, A3, A7, A8, A12, A13, A18, A23, A27 and A28) where the 3-4 ring PAHs such as pyrene derivatives are dominant. The pyrolytic contamination of these stations could be attributed to fossil fuel oil particulates emission by commercial vessels.
In sediment, the major problems are the land based and ship-based pollution. The sediments from the Sea of Marmara, show that the port activities are the most serious source of pollution in the around of Ambarli Harbor region. In this study area in which are determined the elevated contents of total aromatic hydrocarbons sediment is also polluted with larger amount of pyrogenic fossil fuel compounds. Therefore the marine sediments are very important in our estimating the degree of the damage given to the ecosystem by such inputs. The results deduced in this study, which for the first fundamental dataset for the region to be used as reference in future.

References
1 - Ünlü S, Alpar B. and Aydin S., 2009.Spectrofluorometric characterization of aromatic hydrocarbon contamination in the sediment from the Zonguldak Industrial region, Black Sea, Turkey. *Fres. Environment. Bullet.,*18(4): 474-480.
2 - Loring D. H., Rantala R.T.T. , 1992. Manual for the geochemical analyses of marine sediments and suspended particulate matter. *Earth-Sci. Rev.* 32: 235-283.
3 - Gomes A.O. and Azevedo D.A., 2003. Aliphatic and aromatic hydrocarbons in tropical recent sediments of Campos dos Goytacazes, R.J. Brazil, *J. Brazi. Chem. Society.*14(3), 358–368.
4 - Readman, J.W., Bartocci J., Tolosa I., Fowler S.W., Oregioni B., and Abdulraheem M.Y. 1996. Recovery of the coastal marine environment in the Gulf following 1991 the war related oil spills, *Mar. Pollut. Bull*., 32, 493–498.
5 - Lloyd J.B.F., 1971. The nature and evidential value of the luminescence of automobile engine oils and related materials. I. Synchronous excitation of fluorescence emission. *J. Forensic Sci. Society* 11, 83–94.

LONG TERM STUDY OF ORGANIC MATTER FLUCTUATION AND MUCILAGE EVENTS IN THE NORTHERN ADRIATIC

Vjerocka Vojvodic [1]*, Jelena Dautovic [1] and Bozena Cosovic [1]
[1] Rudjer Boskovic Institute - vojvodic@irb.hr

Abstract
In the last fifteen years in the northern Adriatic the massive formation of organic aggregates reported as "mucilage phenomenon" occurred with increased frequency. The intensity of this phenomenon varied over the years: (1988, 1991, 1997, 2000-2004) > 1998, 1999. In the period 1998-2008 we have studied seasonal and spatial distribution of the content of dissolved organic carbon, and concentrations of the reactive organic matter with surface active properties.
Keywords: Adriatic Sea, Organic Matter

Introduction
Most hypothesis proposed to explain the mucilage occurrence in the northern Adriatic (NA) recognize the accumulation of dissolved organic matter during the period of stratification as the main precursor of mucilage accumulation [1, 2]. We have undertaken the long-term study in order to see if the problems connected to the harmful mucilage events in NA are becoming worse or better.

Metodology
Dissolved organic carbon (DOC) and surface active substances (SAS) were analysed in the samples collected from the depth of 0.5 m along the transect between Rovinj and mouth of the River Po. SAS were determined by electrochemical method (a.c. polarography) using the calibration curve of model nonionic SAS, Triton-X-100 [3]. DOC was determined by using high temperature catalytic oxidation (HTCO) method.

Results
Over the whole period of investigations the concentrations of DOC and SAS showed regular seasonal patterns, with lower values in winter and higher values in the period from spring to autumn. A marked interanual variability of DOC and SAS values was observed as well. The mean concentrations of DOC (1.07-2.76 mg/L) obtained in the period 1998-2004, which is characterised by mucilage appearance), were up to 40% higher in comparison to the values obtained in 1994 and over the years 2005-2008 (0.82-1.60 mg/L) (Figs. 1a, 1b). No mucilage events were observed in this later period. Interestingly, the same trend of fluctuation was detected for SAS values, which were more than two times higher during mucilage appearance than those observed in the period 2005-2007 (0.025-0.405 mg/L and 0.006-0.151 mg/L respectively) (Figs.1c,1d).

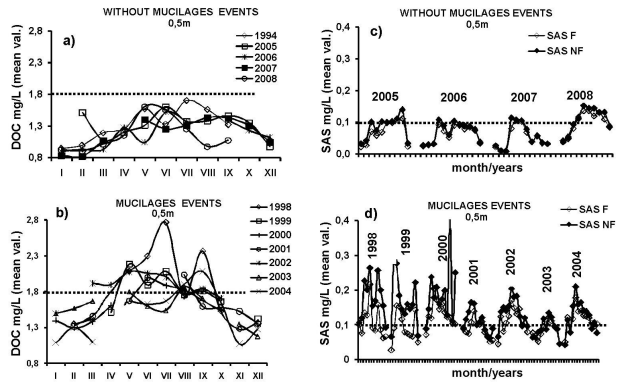


Fig. 1. Fluctuation of DOC (mean values) in the period **a)** 1994, 2005-2008 (without mucilage occurrence), **b)** 1998-2004 with mucilage events as well as fluctuation of SAS (mean values) during **c)** 1994, 2005-2008, **d)** 1998-2004

Conclusion
The seasonal distribution pattern of DOC over the whole period of investigation clearly showed a decreasing trend from 1998 to 2008, in particular after 2002 (Fig. 2). The same decreasing trend, but less pronounced was detected two years earlier (2000) for reactive surface active organic matter (Figs 1c,1d). Reduced content of SAS, as well as the absence of the greater accumulation of dissolved organic carbon in recent years, probably have an important role on disappearance of mucilage events contributing to the improvement of the northern Adriatic Sea ecosystem.

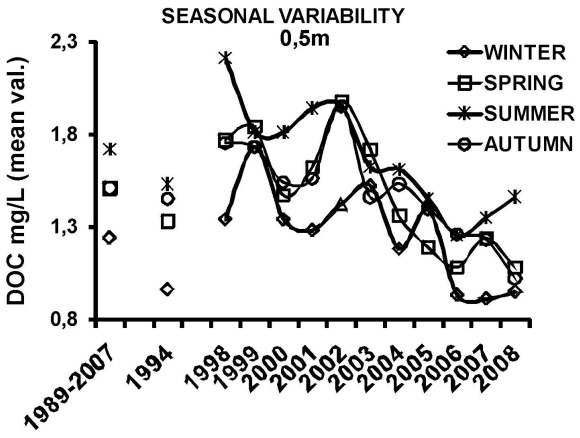


Fig. 2. Seasonal fluctuation of DOC (mean values) in period 1998-2008

Acknowledgement
The financial support of the Croatian Ministry of Science (Project "Jadran", 10M92) is gratefully acknowledged.

References
1 - M. Giani, F. Savelli, D. Berto, V.Zangrando, B. Cosovic, V. Vojvodic. Temporal Dynamic of Dissolved and Particulate organic Matter in the Adriaric Sea. Sci.Tot. Environ, 353, Issue 1-3, 15-dec-2005.
2 - Giani M., D.Degobbis D. and .Rinaldi A. (eds), 2005. Mucilages in the Adriatic and Tyrrhenian Seas. *In*: Science of the Total Environment, Elsevier, the ISSN: 0048-9697, Volume 353, Issue: 1-3, 15-Dec-2005.
3 - Cosovic B. and Vojvodic V., 1998. Voltametric Analysis of Surface Active Substances in Natural Seawater. *Electroanalysis*, 10, (6), 429-434.

SPATIAL AND TEMPORAL VARIATIONS OF ISOTOPIC COMPOSITION OF PRECIPITATION IN SLOVENIA

Polona Vreca [1]*, Mihael Brencic [2], Nives Ogrinc [1] and David Kocman [1]
[1] Department of Environmental Sciences, Jožef Stefan Institute - polona.vreca@ijs.si
[2] Department of Geology, Faculty of Natural Sciences and Engineering, University of Ljubljana, Askerceva cesta 12, SI-1000 Ljubljana, Slovenia

Abstract
Long-term monthly and short-term monthly and daily data on isotopic composition of precipitation together with meteorological data were used to trace spatial and temporal variations of isotopic composition of precipitation in Slovenia. A spatial distribution of stable oxygen isotopic composition in precipitation over Slovenia has been generated using temperature, latitude and altitude dependences.
Keywords: Hydrology, Monitoring, Adriatic Sea

Introduction
Modern investigations of water cycle include determination of isotopic composition of precipitation, surface water and groundwater because isotopes of water molecule offer a broad range of possibilities for studying processes within the water cycle and thus became an important tool in isotope hydrology, as well as in studies related to atmospheric circulation and paleoclimatic investigations. As the recharge of groundwater is mainly due to precipitation, it is of utmost importance to know the isotopic composition of precipitation, and its seasonal and spatial variations. The Global Network of Isotopes in Precipitation (GNIP) organised jointly by the International Atomic Energy Agency (IAEA) and the World Meteorological Organization (WMO) in 1961 is a database that contains data on stable isotopic composition of hydrogen and oxygen, tritium activity, and relevant meteorological data on a monthly basis, and is thus extremely valuable for modelling climatic changes, as well as in hydrological and hydrogeological investigations. However, the need for a much more refined understanding of isotope variations was indicated in climatic studies and therefore the IAEA initiated a programme of collecting new data at a higher spatial density and temporal frequency in the Mediterranean basin, including the eastern Adriatic coast [1]. The aim of this paper is to present a review of isotopic results obtained since 2001.

Methodology
Monitoring of isotopic composition of oxygen and hydrogen in monthly precipitation has been performed at the continental sampling station in Ljubljana (Slovenia) since 1981 within the GNIP [2]. In the framework of an IAEA Co-ordinated Research Programme [1, 3] the monitoring programme was extended to two additional sampling stations on the coast of Northern Adriatic (Portoroz) and its near hinterland (Kozina) in the south-western, Mediterranean region of Slovenia in October 2000 during which monthly and occasionally also daily sampling was performed [1, 4]. Basic descriptive statistics, deuterium excess and local meteoric water lines were calculated. In addition, altitude effect and isotope - surface temperature relations were determined. Finally, modelling of spatial variations of isotopic composition of oxygen over Slovenia was performed.

Results and discussion
The highest precipitation amount weighted mean hydrogen and oxygen isotopic values are observed at Portoroz, while the lowest values are characteristic for the continental station of Ljubljana (Table 1). The orthogonal regression equations between the isotopic values of individual monthly samples representing local meteoric water lines (LMWLs) are:
- $\delta^2H = (8.1 \pm 0.1)\delta^{18}O + (9.8 \pm 0.7)$ for Ljubljana (1981-2006)
- $\delta^2H = (7.7 \pm 0.4)\delta^{18}O + (7.3 \pm 2.2)$ for Portoroz (2001-2003)
- $\delta^2H = (7.7 \pm 0.3)\delta^{18}O + (9.6 \pm 0.7)$ for Kozina (2001-2003)

Weighted mean d-excess values (Table 1) are close or above 10‰, showing the influence of Mediterranean air masses in south-western part of Slovenia. The altitude effect determined by vertical $\delta^{18}O$ gradient (–0.30‰ per 100 m) was calculated using the isotope data obtained for stations Portoroz and Kozina. Furthermore, the continental station Ljubljana shows higher correlation between oxygen isotopic composition and mean monthly surface temperature (r = 0.75) than the coastal station Portoroz (r = 0.36) indicating that temperature information can only be seen at continental stations and has less influence on the isotopic composition of precipitation at coastal stations.

Comparison of the monthly and daily isotopic composition of precipitation collected from October 2002 to September 2003 at Portoroz and Kozina showed profound differences between the two sets of data. It was shown that in investigated area during rain event of several days sources of air masses have changed during the course and mixing of air masses originating from the continent and from Mediterranean cyclogenesis appeared [4].

The spatial distribution of $\delta^{18}O$ in precipitation has been explained by a simple multiple regression models, based on the meteorological (temperature) and geographic factors (latitude and elevation). Continuous digital map of the $d^{18}O$ distribution over Slovenia has been generated using GIS tools (Figure 1).

Tab. 1. Weighted mean hydrogen and oxygen isotopic composition and deuterium excess values in ‰

Station	$\delta^{18}O$	δ^2H	Deuterium excess
Ljubljana (1981-2006)	-8.6	-59	9.5
Portoroz (2001-2003)	-6.3	-40	10.3
Kozina (2001-2003)	-7.8	-50	12.3

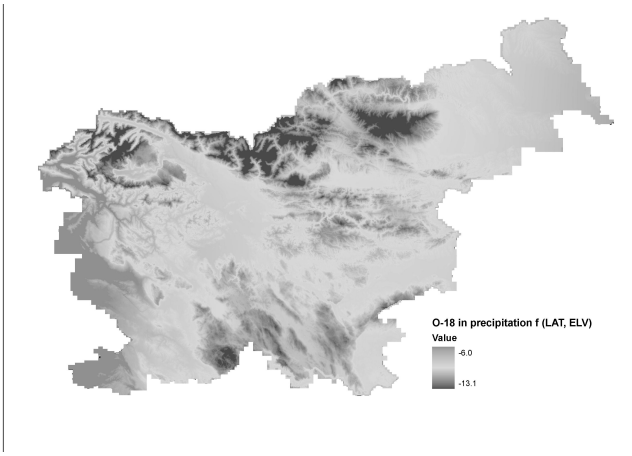


Fig. 1. Continuous digital map of the oxygen isotope distribution as a function of latitude and elevation

References
1 - IAEA, 2005. Isotopic Composition of Precipitation in the Mediterranean Basin in Relation to Air Circulation Patterns and Climate. TECDOC Series No.1453, IAEA, Vienna, 223 pp.
2 - Vreca P., Krajcar Bronic I., Leis A., Brencic M., 2008. Isotopic composition of precipitation in Ljubljana (Slovenia). *Geologija*, 51: 169-180.
3 - Vreca P., Krajcar Bronic I., Horvatincic N., Baresic, J., 2006: Isotopic characteristics of precipitation in Slovenia and Croatia: Comparison of continental and maritime stations. *Journal of Hydrology*, 330: 457-469.
4 - Vreca P., Brencic M, Leis A., 2007. Comparison of monthly and daily isotopic composition of precipitation in the coastal area of Slovenia. *Isotopes in Environmetal and Health Studies*, 43: 307-321.

IRON(III)-ORGANIC COMPLEXES DISSOLVED IN SEAWATER: CHARACTERIZATION OF IRON(III)-SUCCINATE AND IRON(III)-MALATE COMPLEXES IN AQUEOUS SOLUTION

Petra Vukosav [1]* and Marina Mlakar [1]

[1] Ruder Boškovic Institute, Division for Marine and Environmental Research, Bijenicka 54, 10 000 Zagreb, Croatia - petra.vukosav@irb.hr

Abstract

Iron(III), as an essential element and one of the most important element -for biochemical processes in the marine environment, is bioavailable only in dissolved form. By complexing with succinic and malic acid, intermediates in the citric acid cycle, iron(III) forms soluble complexes in aqueous solutions. Each organic acid form with Fe(III) several complexes, depending on acids concentration and pH (4.5 – 11). All investigated complexes showed stability for rather long period of time (weeks to years).

Keywords: Trace Elements, Phytoplankton, Electrochemistry

Introduction

Dissolved iron(III) is very important element for marine organisms (for their biochemical and physiological functioning). Despite its abundance in the environment, dissolved Fe^{3+} in the oceans is present at low concentrations, $<10^{-9}$ mol L^{-1} (>99%), mostly in organic complexes. Low solubility of Fe^{3+} under oxidizing conditions is caused due to the formation of insoluble Fe(III)-hydroxides and oxides and that is why Fe(III) is a limiting factor for primary production [1]. Bioavailabile forms of iron(III) are, among others, complexes with succinic and malic acid [2]. Therefore, these complexes are possible candidates in the iron fertilization experiments in high-nutrient low-chlorophyll (HNLC) areas of the Oceans.

Results and discussion

Measurements were preformed by square wave voltammetry (SWV) and by UV-Vis spectrophotometry [3].

Iron(III) with different concentrations of succinic acid (0.04 - 0.5 mol L^{-1}) in pH range 5.2 – 7.4, measured by SWV, gave redox responses of two Fe(III)-succinate complexes (Figure 1. A). Within C_{suc} from 0.04 to 0.12 mol L^{-1}, Fe (III)-succinate (I) reduction peak at the potential $\approx$ -0.22 V was registered, and with $C_{suc} \geqslant$ 012 mol L^{-1}, Fe(III)-succinate (II) complex at $\approx$ -0.37 V. The formation kinetics of both complexes was slow, Fe(III)-succinate complex (I) was equilibrated within 17 h, and Fe(III)-succinate complex (II) in about 15 h. However, after equilibration period, complex (I) was stable in the solution for about a week, and complex (II) for about 10 h. Analysis of UV-Vis spectra under same experimental conditions were processed by multivariate non-linear least-square fitting program Specfit [3]. The model, taking into account obtained iron(III) complexes by SWV, presumed that stoichiometry ratio of Fe(III):succinate complexes (I) and (II) was 1:2 and 1:3, respectively .

Three iron(III) - malate reduction peaks were detected in the pH range from 4.5 to 11, with malic acid concentration C_{mal} = 0.1 mol L^{-1}. By SWV first complex reduction was registered at about -0.1 V (pH from 4.5 to 6.5), second one at about -0.35 V (pH = 6.5 - 9) and third at about -0.6 V (pH = 8.5 - 11) (Figure 1. B). Formation kinetics of this complexes was fast, and equilibrium was reached within 30 minutes. Fe(III)-malate complexes were much more stable than complexes with succinic acid, since they were detected in the solution even after one year. By UV-Vis spectrophotometry in the pH range from 1.5 to 8 three complexes were registered, as well, with two isosbestic points at 310 and 392 nm. Changes in spectra were detected in the pH range from 1.5 to 6.5, but at pH > 6.5 spectra remained almost unchanged. Principal Component Analysis (PCA) of spectra gave three spectrally distinguishable Fe(III)-malate complexes. Combination of voltammetric and UV-Vis results persumed stoichiometry of compexes: in the pH range from 1.5 – 3 exist complex Fe(mal) (with undisociated hydroxyl group at the second carbon atom in malic acid molecule); Fe(mal) and $Fe(mal)_2$ complexes (with dissociated hydroxyl group) in the pH range from 3.5 to 6.5 and these complexes gave reduction peak 1 in Fig.1B. In the pH range from 6.5 to 9 exists compex $Fe(mal)_2(OH)_x$ (peak 2) and in the pH range from 8.5 to 11 complex $Fe(mal)_2(OH)_y$ (peak 3) is present.

Conclusion

Obtained results showed that succinic and malic acids form stable dissolved Fe^{3+} complexes in the pH range from 4 to 11 that remain in the solution for rather long period of time. The addition of relatively small amount of described iron complexes to the phytoplankton culture (*Dunaliella* sp.) in laboratory conditions resulted in incerased production of phytoplankton biomass.

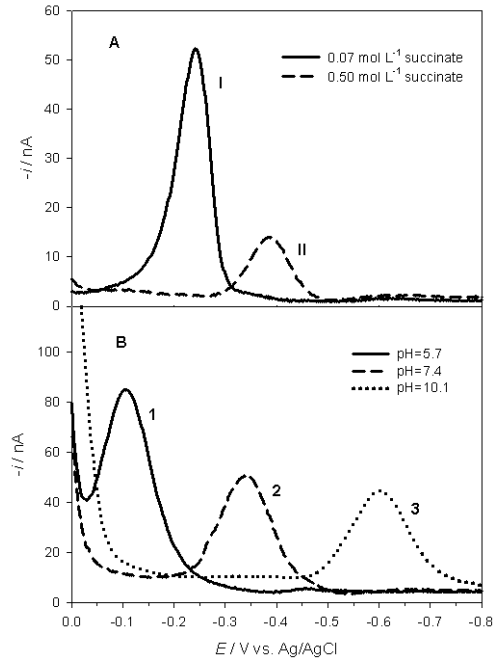


Fig. 1. A) SW voltamograms of Fe(III)-succinate complexes in 0.55 mol L^{-1} NaCl with C_{Fe}= 4 x 10^{-5} mol L^{-1}, pH=6.00 and C_{suc}: (I) 0.07 and (II) 0.5 mol L^{-1}.

B) SW voltamograms of Fe(III)-malate complexes in 0.55 mol L^{-1} NaCl with C_{Fe}= 4 x 10^{-5} mol L^{-1}, C_{mal}= 0.1 mol L^{-1} and pH: (1) 5.7, (2) 7.4 and (3) 10.1.

References

1 - Hiemstra T. and van Riemsdijk W. H., 2006. Biogeochemical speciation of Fe in ocean water. *Mar. Chem*., 102 (3-4): 181-197.

2 - Puskaric S. And Mortain-Bertrand A., 2003. Physiology of diatom Skeletonema costatum (Grev.) Cleve photosynthetic extracellular release: evidence for a novel coupling between marine bacteria and phytoplankton. *J. Plankton Res.*, 25(10): 1227-1235.

3 - Cmuk P., Piantanida I. And Mlakar M., 2009. Iron (III)-complexes engaged in the biochemical processes in seawater. I. Voltammetry of Fe(III)-succinate complexes in model aqueous solution, *Electroanalysis*, 21(23): 2527-2534.

DOES POLLUTION THREATEN FETHIYE-GOCEK BAY (TURKEY) SPECIALLY PROTECTED AREA MARINE ECOSYSTEM AND ITS FUNCTIONING?

Aysen Yilmaz [1]*, Betil Ergev [2] and Okan Taktak [2]
[1] Institute of Marine Sciences, 33731, Erdemli-Mersin, Turkey - ayilmaz@metu.edu.tr
[2] Derinsu Underwater Engineering and Consulting, Nilgun Sk. 5/1 Kavaklidere 06680 Ankara, Turkey

Abstract
Fethiye-Gocek Specially Protected Area (SPA) is one of the 14 SPAs in Turkey and it is located in the south-west corner of the Anatolian peninsula - on the Mediterranean coast. Fethiye-Gocek Bay hosts more than double of the normal population in summers. Marinas exceeding the carrying capacity and pollution from land based sources threatens the marine ecosystem. The main aim of this project was to determine the biodiversity of this beautiful bay but main hydro-chemical, biological and pollution parameters were also determined in order to understand the ecosystem and the risks for its functioning.
Keywords: Marine Parks, Coastal Systems, Pollution

Introduction
The coastline of Fethiye-Gocek SPA is about 235 km and it covers 817 km^2 area including coastal and marine areas of all figures (landscapes, bays, islands etc.). Total population of the area is 181,000 (2009) and this number is almost double during the high seasons (from April to November). Fethiye-Gocek bay is naturally protected from strong winds and less affected by the main current system (the Asia Minor current) even though the total depth at the large entrance of the bay is about 800m deep. This natural harbor has 5 marinas with totally 1210 yacht capacity and the marinas are almost full during summer months. Besides the in situ marine pollution, the input of pollutants from land-based sources threatens the area; since the level of almost all the critical pollution parameters exceed the limits especially in the Fethiye inner bay.

Results and Discussion
The data is obtained very recently (April and August 2008) and totally 15 stations were visited in the Bay. Sea surface temperature was relatively high in the summer (up to 29.4 ºC) and seasonal thermocline was well established and generally observed at 20-60m. The surface salinity was measured in the range of 37.37 – 39.47 ‰ and it was reduced down to 31.86 ‰ at some coastal stations where there is fresh water input. The RDCP data revealed that currents were relatively weaker in summer months and stagnant water masses were especially observed near coastal zones. The reverse current system was characteristics of the Bay where surface and deep currents were in different directions and mainly directed towards to inside of the Bay at the surface.
The Secchi Disc Depth was measured in the range of 10-28 m in the Bay except a very low value (4.8m) recorded in Fethiye inner bay. It was assumed that the bottom of the euphotic zone coincided with the bottom of the shallow inner Bay. It seems this affected the bottom autotrophic production by blue-green algae since scuba diving results showed that life was poor at this location. The high level of suspended sediment (16.8-29.6 mg/L) caused the extinction of the light at shallower depths with respect to those observed in the Mediterranean offshore. The level of oxygen saturation was determined in the range of 96-110% except some unacceptable values (47-59 %) obtained near the Fethiye and other inner bays. These extreme values were definitely far from the general picture, since the minimum level of oxygen saturation in the deep offshore waters were determined as of 70-80% due to effective vertical mixing and overturning [1]. The level and distribution of nutrients measured in the area showed similar patterns with the previous work [1] and low concentration of nutrients (PO_4: 0.7-8.5 µM; NO_3: 0.06-0.16 µM; NH_4: Below Detection Limits; Si: 4.74-18.1 µM) caused low level of autotrophic production. The average chlorophyll-a concentration representing the phytoplankton biomass was 0.3 µg/L (Range: 0.09-1.06 µg/L) in the surface waters and the primary production was dominated by regenerative production.
Heavy metal concentrations in the Bay were in the range of acceptable limits (e.g. Cupper: 3.00-9.50 µg/L; Zinc: 14.00-47.6 µg/L) and the highest concentrations were detected in the Fethiye inner bay. The same trends were observed for total phosphorus, nitrogen, organic carbon and heavy metals within the sediment samples and maximum concentrations were measured in the inner bay. Microbial pollution level were generally under the limits but they exceeded the limits over twice in the inner Fethiye bay (e.g. Total Coliform: 930 individual/100 mL) causing unhealthy recreational waters to be present in the study area.
In summary, Fethiye-Gocek bay has very regular Mediterranean lower trophic level ecosystem. The level of pollution caused by heavy boating activities for leisure and input of pollutants by land based sources (e.g. municipal wastes) is at the very sensitive limit. The biogeochemical cycling seems to be open to change due to the external strains like the input of additional nutrients from the land. Scuba diving between 0-55m in the same study showed that even though the area is under the risk of pollution, the biodiversity is rich (e.g. 24 taxonomic group and 1545 species were determined in the area where 44 of them were recorded for the first time along the Turkish coasts). The area is being one of the attractive tourist (both national and international) point with its marbles nature and its historical/cultural richness but everybody should note that sustainable development (e.g. in tourism sector) is only possible with the efforts for sustainable nature and effective environmental protection.

Acknowledgement: This Project has been supported by Turkish Ministry of Environment and Forestry, Environmental Protection Agency for Special Areas.

References
1 - Yilmaz A. and S. Tug?rul, 1998. The effect of cold- and warm-core eddies on the distribution and stoichiometry of dissolved nutrients in the Northeastern Mediterranean, Journal of Marine Systems, 16(3-4): 253-268.

THE DETERMINATION OF ORGANOTIN COMPOUNDS LEVELS IN SEDIMENT SAMPLES FROM TURKISH AEGEAN SEA COAST

Aykut Yozukmaz [1], Fatma Sanem Sunlu [1], Ugur Sunlu [1]* and Meral Özsüer [1]
[1] Ege University, Faculty of Fisheries, Dept. of Hydrobiology - ugur.sunlu@ege.edu.tr

Abstract
In this study, from the North tot he southern part of all the Aegean Sea coast line predetermined from 9 stations, the sediment samples were collected during summer-winter period in 2009 and organotin compounds (OTC) concentrations were detected at the ng g^{-1} Sn dry weight (d.w.) within sediment. In this way, effects of the most important organic tin contamination points of maritime activities in the Aegean Sea were try to determine in the coastal zone along the Turkish Aegean Sea.
Keywords: Aegean Sea, Coastal Waters, Sediments, Trace Elements, Pollution

INTRODUCTION
The purpose of the present study is determined OTC levels and assess the hot spots at the most important maritime points along the Aegean Sea. There are considerable maritime activities along the Aegean Coast, relating the heavy maritime activities, e.g., fishing and yachting.
Hence their high atomic weights and low aqueous solubilities, OTC tend to adsorb onto particles and sink directly onto the sediment, here it accumulate and release into water column by re-suspension of particles. Although its extremely hazardous to aquatic ecosystem, there are very few data for OTC levels and its detrimental impacts on the marine environment of Aegean Sea.

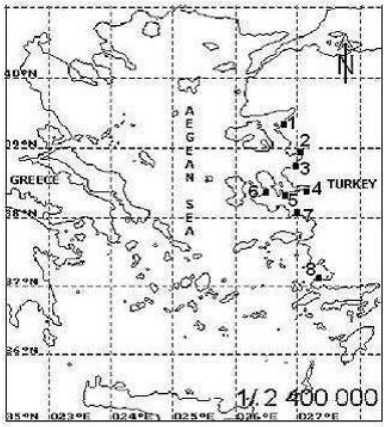


Fig. 1. The Map of the Sampling Locations

MATERIAL AND METHOD
Aegean Sea is 380 miles (612 kms) long and 186 miles (299 kms) wide with 83,000 square miles (215,000 square km) total area. It is located between 41-45 N latitude and 23- 27/28 E longitude [1]. Sediment samples were collected from 8 predetermined stations from northern stretch of Aegean Sea, Ayvalik Marina to southern stretch Bodrum Marina along the coastal zone between March 2009 and August 2009 (Fig.1.). Reference stations determined relatively far from the maritime activity where human and marine environment engaged as in beaches and piers.
Sediment samples were collected by standard (6x6x6) stainless steel Ekman Grab. Sample analysis carried out GC/MS, HP Agilent 6890 coupled 5973N Mass Selective Detector [2] (non-detected-nd. limits for MBT, DBT, TBT were 0.003, 0.001, 0.001 ng g^{-1} Sn respectively).
In order to quality control of the analytical results CRM-462 (Coastal Sediment for Butyltins) is provided from IRMM (Institute for Materials and Measurements) and analysis of CRM-462 proved that the method is able to accurately determine OTC.

RESULTS AND DISCUSSION
As a result of winter sampling the highest ∑butyltin level was detected from the station 2 (1752.4 ng g^{-1} Sn). The lowest ∑butyltin level was measured from the station 5 (nd.). Mean concentration of ∑butyltin for overall stations was 1091.5 ng g^{-1} Sn. The highest concentration of ∑butyltin was detected in station 1 (1464 ng g^{-1} Sn) and the lowest was measured at the stations 7, 3, 4, 5 from the reference points (nd.). Mean concentration of ∑butyltin for overall reference points was 495.9 ng g^{-1} Sn.
At the end of the summer sampling, the highest total ∑butyltin level was seen in station 2 (4278.4 ng g^{-1} Sn). The lowest ∑butyltin level was measured at station 5 (983, 6 ng g^{-1} Sn). Mean concentration of ∑butyltin for all stations was 2691,2 ng g^{-1} Sn. For the reference stations the highest and lowest levels of ∑butyltin was measured 2207,6 ng g^{-1} Sn for station 4 and nd. for station 7 respectively. Mean concentration of ∑butyltin for all reference stations was determined as 1343.9 ng g^{-1} Sn. High levels of tin compounds measured in summer-winter period along the Cost of Aegean Sea may be the results of the numerous marinas (operating 100% or more capacity almost all year long) and strong adsorption tendency of TBT. Additionally, high concentrations of TBT suggesting the illegal usage of TBT-based anti-fouling paints, on ships smaller than 25 m [3]. Furthermore, ongoing contamination of Aegean Sea could be consequence of leaching from the boat, painted before the ban, or the compounds' long-lasting effectiveness time (5-7 years).

Tab. 1. Reported OTC' levels from the world (ng g^{-1} Sn d.w.) [4]

Sampling Areas	Levels of OTC (ng g⁻¹ Sn)		
Regions	MBT	DBT	TBT
Marinas of the U.S.A.			
East-West Canada Coast	nd.-330	nd.-100	nd.-5100
Crystal Lake, USA	21.3-320	59-350	1.5-14,000
Asian Marinas			
Osaka Harbor	nd.	nd.	10-2100
Malaysian Coast	5.0-360	3.8-310	2.8-1100
West cost of India	n.a.	nd.-469	5-2384
Vietnam Coast	3.9-30	8.1-42.7	8.3-51
European Marinas			
North-west Sicily coastline	nd.	nd.	3-27
Portuguese coast	5.2-78	5.3-65	3.8-12.4
North coastline of Spain	860-2870	150-710	50-5480
South-west of France	1.0-125	nd.-87	nd.-89
Marinas of Turkey			
Aegean Sea (In this study)	nd.-2598	nd.-1371	nd.-3008

Survey researches from all over the world reported that organic tin pollution is still a matter of concern. The two-way researches revealed that there are still significant TBT pollution along coastal zones of Pacific, Atlantic, Indian Oceans and of marinas and harbors. In conclusion; comparing the levels between measured OTC levels along Turkey coast of Aegean Sea and Mediterranean Marinas' former's levels are rather high (Table 1.). At the end of the results, we determined that the total TBT concentrations in the sediment samples showed the significant spatio-temporal changes .

References
1 - http://www.britannica.com/EBchecked/topic/6988/Aegean-Sea
2 - Centineo G., Rodriguez-Gonzalez P. and Ignacio Garcia Alonso J., 2007, Determination of Butyltin Compounds in Environmental Samples by Isotope Dilution GC-MS. Department of Physical and Analytical Chemistry University of Oviedo, Spain. 5989-7001 EN.
3 - Ceulemans, M., Slaets, S., Adams, F., 1998, Speciation of organotin in environmental sediment samples. *Talanta* 46, 395–405.
4 - Ladislao, B.A., 2008, Environmental levels, toxicity and human exposure to tributyltin (TBT)-contaminated marine environment. A review. *Environment International*, 34, 292–308.

DEEP BASIN TURBIDITES AS A PREVIOUSLY UNRECOGNIZED SINK FOR HYDROGEN SULFIDE IN THE BLACK SEA

Mustafa Yucel [1]* and George W Luther [1]

[1] University of Delaware, College of Earth Ocean and Environment, 700 Pilottown Road, Lewes DE 19958, USA - mustyucel@gmail.com

Abstract

Speciation of sulfur and iron was investigated in the solid phase of Black Sea sediments (Unit 1 type and turbidites) collected during the R/V Knorr 2003 Black Sea expedition. Other than pyrite, solid phase sulfur in the upper Black Sea sediments existed as inorganic S(0) and acid-volatile sulfides (predominantly FeS) in the anoxic basin turbidites, and organic sulfur as humic sulfur in the uppermost 0-2 cm of the central basin sediments. A mathematical model was designed to simulate the temporal changes in the Fe-S chemistry in the anoxic basin turbidites, and successfully showed that turbidites were a previously unrecognized sink for sulfide in the Black Sea and can account for 14% of the annual burial of sulfur.

Keywords: Black Sea, Sediments, Geochemistry, Redox

Deep anoxic basin turbidites are a commonly reported feature of deep-basin Black Sea sediments [1, 2] but their chemical composition remained unexplored except for total elemental analysis. The recently found unexpected variability in the porewater chemistry [3] in the anoxic basin sediments could well be due to the differing solid phase compositions as a result of the presence of turbidites which were emplaced there after the 1999 earthquakes (mag. 7.4 and 7.2) in northwestern Turkey. In order to address these issues and to assess the impact of turbidites to Black Sea anoxic basin sulfur chemistry, detailed solid phase speciation of Fe and S will be reported and a mathematical model will be presented.

Pyrite – sulfur was the major phase in all anoxic basin cores [200-400 µmol (g dry wt)$^{-1}$]. However, zerovalent sulfur and humic sulfur also reached very significant levels: up to about 109 and 80 µmol (g dry wt)$^{-1}$, respectively [4]. Humic sulfur enrichment was observed in the surface fluff layers of the eastern central basin sediments where Unit-1 type depositional conditions prevail. Elemental sulfur accumulated as a result of porewater sulfide oxidation by reactive iron oxides in turbidities from the anoxic basin margin and western central basin sediments. The accumulation of elemental sulfur to a level close to that of pyrite-sulfur in any part of central Black Sea sediments has never been reported before and this finding indicates deep basin turbidites prevent the build-up of dissolved sulfide in the sediment. This process also contributes to diagenetic pyrite formation whereas, in the non-turbiditic parts of the deep basin, water column formed (syngenetic) pyrite dominates the sulfur inventory. Our study shows that the interactions between depositional patterns (Unit 1 vs. turbidite), redox state of overlying waters (oxic-suboxic-sulfidic) and organic matter content determine sulfur speciation and enable the accumulation of elemental sulfur and organic sulfur species close to a level of pyrite-S.

A time-variable mathematical model was constructed to further explore the non-steady-state diagenesis of Fe-S species in a turbidite mud emplaced on normal anoxic-sulfidic deep Black Sea sediments. The turbidite layer was 20 cm thick and initially contained 80 µmol (g dry wt.)$^{-1}$ of Fe(III) in the form of goethite, which led to the rapid (1 day) oxidation and depletion of porewater sulfide and formation of solid phase sulfur intermediates such as S(0) and FeS. S(0) accumulated faster than FeS and was present in the sediment at high concentrations after 5-8 years following the deposition of the turbidite. Reduced iron was in the solid phase long after the consumption of all Fe(III), enabling the coexistence of S(0) and solid-phase reactive iron (which has not been sulfidized yet) for a long period of time. The porewaters had sub-micromolar concentrations of dissolved sulfide in the first 2 years after deposition with Fe (II) exceeding 1 mM. The turbidite layer served as a sink for the sulfide from the overlying waters for about 10 years after its deposition. These results agreed with the solid phase data for the western central station (30) and our suggestion that an earthquake-induced turbidity current could have transported iron oxides from the southwestern shelf/slope as far as 150 km in the western central Black Sea and caused massive oxidation of sulfide after the 1999 earthquakes in Northwestern Turkey.

Considering the ubiquity of the deep-basin turbidites found in the Black Sea and the dense tectonic activity on the Northern Anatolian Fault in Northern Turkey, an estimated 0.144 Tg sulfur / year could be buried as S_8 and FeS_2 due to the earthquake-induced turbidites. This value is about 14 % of the annual sulfur burial (as pyrite) and 3-5 % of the annual sulfide oxidation due to lateral injections of oxic Mediterranean waters to the anoxic-sulfidic Black Sea waters. It is highly likely that earthquake-induced turbidites and subsequent sulfide oxidation in the deep basin represent a previously unrecognized sink in the budget of hydrogen sulfide in the Black Sea.

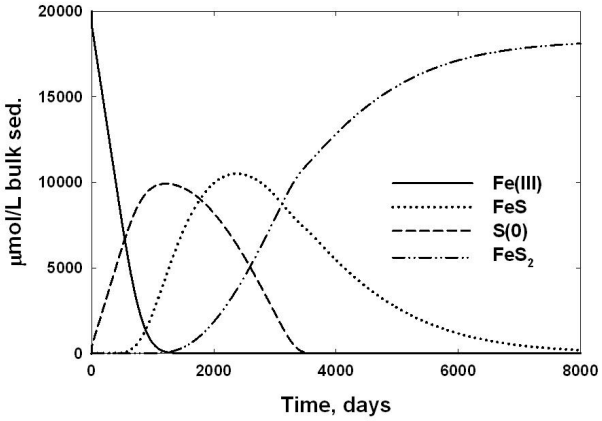


Fig. 1. Model output for the solid phase S-Fe species during the 8000 day simulation period. Time 0 indicates the deposition of the Fe(III) containing turbidite. Initially only dissolved sulfide and solid phase Fe(III) are present in the system. As the reactions progress sulfur intermediates, S(0) and FeS form in the solid phase. With time S(0), FeS and dissolved sulfide form pyrite, and the system reaches steady state after about 7000 days or 19.2 years.

References

1 - Jipa, D. C., 1974. Graded bedding in recent Black Sea turbidites: a textural approach. In *The Black Sea – Geology, Chemistry and Biology (Edited by Degens, E. T. and Ross, D. A.)*. Published by The American Association of Petroleum Geologists, Tulsa, Oklahoma, U.S.A.

2 - Lyons, T.W., 1991. Upper Holocene sediments of the Black Sea: summary of the Leg 4 box cores (1988 Black Sea Oceanographic Expedition). In: *J. W. Murray and E. Izdar (eds.), Black Sea Oceanography*, NATO, Adv. Stud. Inst. Ser., Kluwer, Dordrecht, pp. 401-441.

3 - Konovalov, S.K., Luther, G.W., and Yücel, M., 2007. Porewater redox processes and sediments in the Black Sea sediments. *Chemical Geology* **245**, 254-274.

4 - Yucel, M., Konovalov, S. K., Moore, T., Janzen, C., Luther, G. W. (in press) Sulfur speciation in the upper Black Sea sediments, Chemical Geology.

SIMULATING THE INTERANNUAL VARIABILITY OF THE ADRIATIC SEA ECOSYSTEM DYNAMICS

Marco Zavatarelli [1]*, Emanuela Clementi [1] and Paolo Oddo [2]
[1] Bologna University Phys Dept. - Marco.Zavatarelli@unibo.it
[2] INGV

Abstract
The Adriatic Sea ecosystem dynamics has been simulated, under high frequency, interannually varying, surface forcing, with a coupled physical/biogeochemical modelling system composed by the Princeton Ocean Model (POM) and the Biogeochemical Fluxes Model (BFM). The high frequency forcing for the modelling system is from operational atmospheric circulation analyses. The preliminary simulations results relative to both the general circulation and the biogeochemical processes are assessed by comparing them with available and remotely sensed data. Particular emphasis is put on the analysis of the biogeochemical processes variability induced by the strongly inter-annually varying circulation dynamics (current systems, dense water formation etc.) and by the variability in the Po river freshwater and nutrient forcing.
Keywords: Models, Coastal Models, Adriatic Sea

Introduction
The Adriatic Sea ecosystem is characterised by a strong spatial and temporal variability ([1] and [2]) due to the atmospheric forcing functions, the circulation patterns, the fresh water river runoff that strongly affects spatial and temporal variability and distribution of biogeochemical properties in the northern Adriatic Sea [3].

The objective of this research is to simulate with a three-dimensional coupled numerical model the Adriatic Sea ecosystem dynamics under high resolution and high frequency, interannually varying, surface forcing conditions; to analyse numerical results in terms of Nutrients, Chlorophyll, Primary and Bacterial production variability.

Model
The three-dimensional ecosystem numerical model used is a coupled hydrodynamic/ biogeochemical model.
The circulation model is the Princeton Ocean Model (POM), a three-dimensional, primitive equation, time-dependent, sigma-coordinate, free surface, estuarine and coastal ocean circulation model [4].

The ecological model used in this research is the Biogeochemical Flux Model (BFM) [5]. The model describes physiological and population processes of lower trophic levels in the marine environment. Biota is described by means of three main functional groups: producers, decomposers and consumers, each one defined by internal constituents: Carbon, Nitrogen, Phosphorous, Oxigen and Silicon (in the case of diatoms).

The model has been implemented in the Adriatic Sea basin with a grid resolution of about 2.5 km in horizontal direction and 27 sigma vertical levels with a logarithmic distribution near the surface and the bottom; the minimum depth resolved is 10 m. The model is free surface with time step splitting: the two-dimensional external mode has a 5 sec. time step, while the three-dimensional internal mode has a 500 sec. time step.

Results and conclusions
Simulation results derived from a fully three-dimensional, coupled physical-biogeochemical model implemented in the Adriatic Sea are analysed including Nutrients, Chlorophyll, Primary and Bacterial production. In particular, the monthly averaged numerical results of sea surface Chlorophyll-a concentration are compared with satellite remote sensing data derived from the MERSEA dataset.

The numerical results (Fig. 1) qualitatively agree with the main ecosystem dynamics of the Adriatic Sea. In particular the model is able to represent the high Chlorophyll-a concentration in the northern and western sides of the Adriatic Sea and its decrease towards southern and deeper areas. The seasonal Chlorophyll variability is also qualitatively modelled in comparison with SeaWifs data.

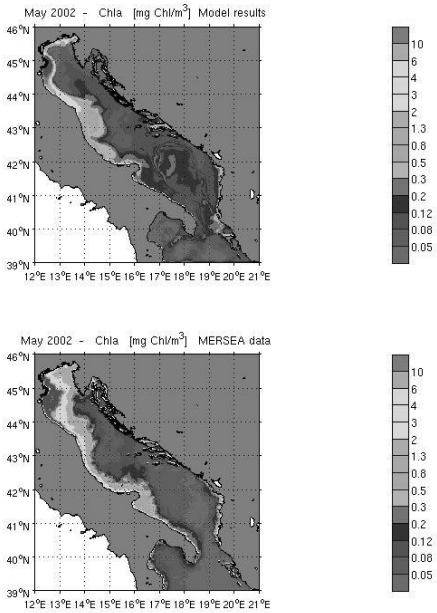


Fig. 1. Chlorophyll-a monthly mean concentration simulated by the model (up) and provided by MERSEA dataset (down) for May 2002.

References
1 - Artegiani A., Bregant D., Paschini E., Pinardi N., Raicich F. and Russo A., 1997. The Adriatic Sea general circulation. Part. I: Air Sea interactions and water mass structure. *J. Phys. Oceanog.*, 27: 1492-1514.
2 - Artegiani A., Bregant D., Paschini E., Pinardi N., Raicich F. and Russo A., 1997. The Adriatic Sea general circulation. Part. II: Baroclinic circulation structure. *J. Phys. Oceanog.*, 27: 1515-1532.
3 - Zavatarelli M., Raichich F., Bregant D., Russo A. and Artegiani A., 1998. Climatological biogeochemical characteristics of the Adriatic Sea. *J. Mar. Syst.*, 18: 227-263.
4 - Blumberg A. and Mellor G., 1987. A description of a three-dimensional coastal ocean circulation model. *In:* Heaps N. (ed), Three-dimensional coastal ocean model. American Geophysical Union, pp 1-16.
5 - Baretta J., Ebenhoeh W. and Ruardij P., 1995. The European Regional Seas Ecosystem Model, a complex marine ecosystem model. *J. Sea Res.*, 33(3-4): 363-379.

THE MEDITERRANEAN SEA ECOSYSTEM DYNAMICS: HINDCAST AND SCENARIO SIMULATIONS

Marco Zavatarelli [1]*, Gelsomina Mattia [1], Marcello Vichi [2] and An Byuong [3]
[1] Bologna University Phys Dept. - Marco.Zavatarelli@unibo.it
[2] INGV-CMCC
[3] INGV

Abstract
High resolution (1/16 degree) simulations of the interannually varying Mediterranean sea ecosystem dynamics are presented and discussed. The modelling system used is constituted by the on-line coupling of the BFM (Biogeochemical flux model) and NEMO (Nucleus for European Modelling of the Ocean). Hindcast for the period (1996-2000) were performed using two different sets of forcing functions: the ERA40 and the results of the ENSEMBLE atmospheric model coupling with the IPCC scenario of Co2 emission A1B. The main aim is to compare the influence that the use of different forcing functions might have on governing the ecosystem dynamics.
Keywords: Models, Circulation Models

Introduction
In the framewok of the EU FP6 Project SESAME (Southern European Seas: Assessing and Modelling Ecosystem changes) project, we performed a set of hindcast and scenario numerical simulations of the coupled ecosystem dynamics of the Mediterranean Sea. The atmospheric forcing functions used for the 1970-2000 hindcast simulations are derived from the ECMWF reanalyses (ERA40), while for the scenario (2070-2100) simulations the forcing functions are computed from atmospheric data originating from the numerical silulation of the global atmosphere carried out under the A1B IPCC scenario of greenhouse gas emission. The aim of the work is to study the impact of "green hous effect" related global change on the Mediterranean Sea ecosystem . The simulation performed for the periods 1970-2000 (hindcast), 2070-2100 (scenarios predictions).

Model
The used modelling system is based on the on-line coupling of a biogeochemical and a general circulation model.

The circulation model is NEMO (Nucleus for European Modelling of the Ocean)-OPA(Ocean PArallelise) version 9.0 [1] primitive equation model implemented in the Mediterranean Sea with an horizontal resolution of 1/16 degree (approsimatevely 7 km) and a vertical resolutionof 72 unevenly spaced vertical z-level.

The ecological model used in ths work is the BFM (Biogeochemical Flux Model) [2-3]. This model is an evolution of ERSEM (European regional sea ecosystem model) [4]. It is a generalized biogeochemistry model based on a biomass-based continuum description of lower trophic levels in the marine environment.

The initial conditions for nutrients and oxygen derived form SEADATANET project (http://www.seadatanet.org) merged with World Ocean Atlas climatology in the Atlantic box. In other hand, the initial conditions for biology are homogeneous guessstimates with vertically-distribuited analytical profiles.

Numerical simulations have been carried out oh a high performance parallel computer.

Results and conclusions
We focused on the temporal evolution of chemical and biological variables. In particular, we compared the monthly averaged numerical results of sea surface Chlorophill-a concentration (Fig.1) derived by simulation forced by ERA40 and satellite data.

The numerical results (Fig.1) show an overall tendency to overstimate phytoplancton biomass. The model is able to reproduce the interannual variability of Chlorophyll surface data. In particular, the relatively high march biomass in the Gulf of Lions and in the Sicily channel detected by the satellite are captured by the model, but with a positive bias particularly strong in the Sicily channel.

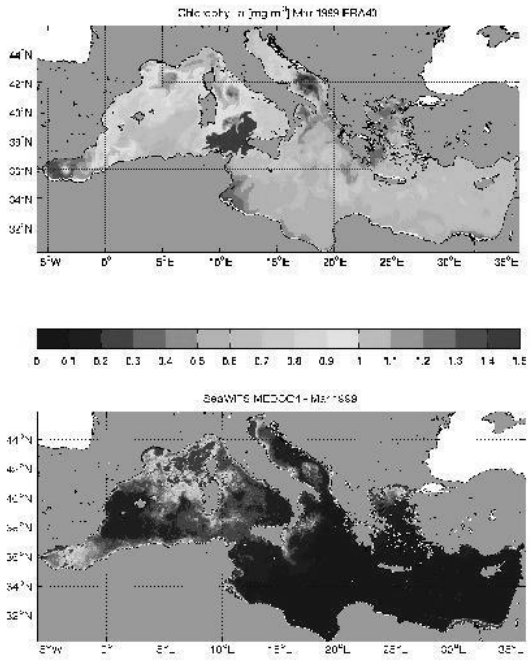


Fig. 1. Chlorophyll-a monthly mean concentration simulated by the model forced by ERA40 (up) and provided by SeaWifs (down) for March 1999

References
1 - Oddo P., Adani, M., Pinardi N., Fratianni C., Tonani M. and Pettenuzzo D., 2009. A nested Atlantic-Mediterranean Sea general circulation model for operational forecasting, Ocean SCI. Discuss., 6, 1093-1127.
2 - Vichi M., Pinardi N., Masina S., 2006. A generalized model of pelagic biogeochemistry for the global ocean ecosystem: PART I. Theory. *J.Mar Syst.*, 64: 89-109.
3 - Vichi M., Pinardi N., Masina S., 2006. A generalized model of pelagic biogeochemistry for the global ocean ecosystem: PART II. Numerical simulations. *J.Mar Syst.*, 64: 110-134.
4 - Baretta J., Ebenhoeh W. and Ruardij P., 1995. The European Regional Seas Ecosystem Model, a complex marine ecosystem model. *J. Sea Res.*, 33(3-4):363-379.

DOM STOICHIOMETRY IN THE MARMARA SEA DURING SEPTEMBER 2008

C. Zeri [1]*, S. Besiktepe [2], A. Pavlidou [1], A. Giannakourou [1] and E. Krasakopoulou [1]
[1] Institute of Oceanograqphy, Hellenic Centre for Marine Research - chris@ath.hcmr.gr
[2] NATO Undersea Research Centre, La Spezia, Italy

Abstract

Dissolved organic carbon, nitrogen and phosphorus (DOC, DON, DOP) were measured in the Marmara Sea, the Dardanelles Straits and the adjacent North Aegean Sea, during September 2008. Additionally, surface waters at selected stations of the Marmara Sea were sampled for bacterial production (BP) and bacterial respiration (BR). The analysis and coupling of chemical and biological data showed that at least during September 2008 newly produced surface dissolved organic matter (DOM) was consumed in the Marmara Sea in times scales shorter than the surface water residence time and that the outflowing waters from the Dardanelles carry DOM of more refractory nature.

Keywords: Aegean Sea, Marmara Sea, Nutrients, Organic Matter

Introduction

The purpose of our study is to present new data on DOC, DON, DOP for the study system and investigate the processes which control their distribution. Also, we focus on the impact of the Dardanelles outflow on the North Aegean trophic status.

Results - Discussion

The Marmara Sea is a two layer counterflow system extensively studied in terms of its hydrography ([1] and references therein) but to a lesser extent in terms of its chemistry [2], [3].Taking into consideration this specific flow regime we present our results in Table I.

Tab. 1. DOC, DON, DOP concentrations (μmol L^{-1}) and ratios in the studied area.

	North Aegean	Dardanelles Straits	Marmara Sea
overflow	σ_θ<28.8	σ_θ<22.4	σ_θ<22.4
DOC	80 ± 15	165 ± 31	172 ± 37
DON	3.97 ± 0.97	6.54 ± 2.55	8.22 ± 0.85
DOP	0.11 ± 0.01	0.19 ± 0.06	0.14 ± 0.07
DOC:DON:DOP	*704:35:1*	*719:33:1*	*1618:73:1*
	n=12	*n=3*	*n=14*
underflow	σ_θ>28.9	σ_θ>28.3	σ_θ>28.3
DOC	63 ± 6	65 ± 2	62 ± 8
DON	3.18 ± 0.34	3.86 ± 0.520	3.60 ± 1.17
DOP	0.11 ± 0.02	0.15 ± 0.04	0.19 ± 0.09
DOC:DON:DOP	*517:29:1*	*440:26:1*	*426:23:1*
	n=12	*n=5*	*n=42*

DOM in the overflow shows a 2-fold decrease in its DOC and DON content while DOP remains constant. DOM in the underflow shows stable DOC, DON, DOP concentrations. DOM stoichiometric ratios shown in Table I are indicative of the presence of considerable amounts of refractory material. The refractory character is more pronounced in the surface low salinity waters. In order to clarify to what extent the concentrations observed in the Marmara Sea reflect merely the mixing of rich in DOM low salinity Black Sea waters with poor in DOM high salinity N. Aegean waters, we plotted our DOC results along the mixing line of the two end members (Figure 1).

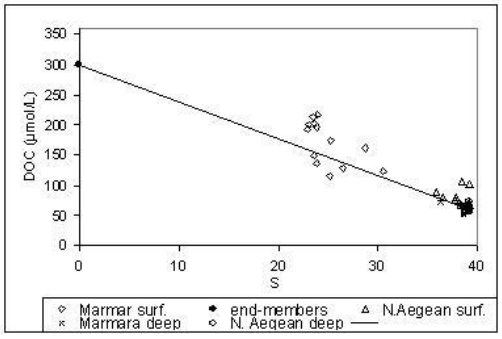


Fig. 1. Figure 1. Mixing line of low salinity high DOC BS waters with high salinity low DOC Aegean waters.

It was shown that in situ DOC production is also taking place in surface waters of the Marmara Sea. Deep waters of the Marmara and the N. Aegean Seas lie very close to the Aegean end member with a very good fit. Surface Aegean waters also show a good fit to the mixing line with the exception of 2 points indicative of an extra DOC source. In systems such as the Marmara Sea with strong influence of terrestrial inputs and freshly produced organic material, it is very difficult to distinguish between refractory and labile forms of DOM. The two layer counter flow and the limited vertical mixing in the Marmara Sea does not allow us to consider bottom water DOC concentration as the refractory one, as it has been proposed for the open ocean. Therefore, in an attempt to get an estimate of DOM lability in the overflowing waters we considered that DOM found there is similar in nature as in surface waters of the Black Sea. In fact the similar nature of POM between the Black and Marmara seas has been reported [4]. The labile+semilabile component in surface waters of the Black Sea has been estimated to be 41% of bulk DOC and 50% of bulk DON [5]. Based on these percentages we calculated the amount of excess DOC and DON in the upper layer of the Marmara Sea and found 71 μmol/L for DOC and 4.1 μmol/L. DOC:DON ratio in this labile+semilabile material is 17.2, a value indicative of relatively fresher material compared to the DOC:DON ratio of the remaining refractory DOM (24.9). Mean depth integrated BP measured in Marmara surface waters was 1.25 μmolC/m^3/h, and BR 0.7 μmol O_2/L/h. Based on these data we calculated the bacterial carbon demand (BCD) and found that 15 μmol C/m^3/h are consumed by the bacterial community. Since the source of this carbon is the labile+semilabile component of DOM, then the time needed for the bacterial community to consume this DOM was found to be ~30 days. This time is less than the mean residence time of surface waters (~ 4 months) in the Marmara Sea before they reach the N. Aegean [1], and implies that at least during September 2008 outflowing waters from the Dardanelles Straits carry DOM of more refractory nature. This is in accordance with the generally low BP values observed in the southern exit of the Dardanelles (0.25 μmolC/m^3/h, present study) and in the N.Aegean (0.21-0.41 μmolC/m^3/h) during the same period (Giannakourou unpublished data).

Acknowledgements

The present study was conducted within the framework of the European IP Project FP6 - *Sesame ECContractNoGOCE-036949*. The data collected during the NRV Alliance cruise to the area which was made possible by the TSS Protocol, including as Participants the NATO Undersea Research Centre (NURC), Turkish Navy Office of Navigation, Hydrography and Oceanography.

References

1 - Besiktepe, S., Sur, H.I., Ozsoy, E., Latif, A., Oguz, T., Unluata, U., 1994. The circulation and hydrography of the Marmara Sea. *Progr. Oceanogr.*, 34, 285-334.

2 - Polat, C., Tugrul, S., 1996. Chemical exchange between the Mediterranean and the Black Sea via the Turkish Straits. *CIESM Science Series* 2, 167-186.

3 - Polat, S.C., Tugrul, S., 1995. Nutrient and organic carbon exchanges between the Black and Marmara Seas through the Bosphorus strait. *Continental Shelf Research*, 15, 9, 1115-1132.

4 - Coban-Yildiz, Y., Altabet, M.A., Yilmaz, A., Tugrul, S., 2006. Carbon and nitrogen isotopic ratios of suspended particulate organic matter (SPOM) in the Black Sea water column. *Deep-Sea Research II*, 53, 1875-1892.

5 - Ducklow, H.W., Hansell, D.A., Morgan, J.A., 2007. Dissolved organic carbon and nitrogen in the Western Black Sea. *Mar. Chem.*, 105, 140-150.

CHARACTERISATION OF NATURAL ORGANIC MATTER IN DEPTH PROFILE OF THE MEDITERRANEAN SEA BY 3D-FLUORESCENCE FOLLOWED BY PARAFAC TREATMENT

H. Zhao [1]*, G. Durrieu [1], R. Redon [1], L. E. Heimbürger [2], A. Dufour [3] and S. Mounier [1]

[1] Laboratoire PROTEE - Bt R, Université du Sud Toulon Var, B.P. 20312, 83957 La Garde Cedex, France - hzhao@univ-tln.fr

[2] Ifremer, Centre de Méditerranée, BP 330, F-83507 La Seyne-sur-Mer, France

[3] UPMC Univ. Paris 06 et CNRS, UMR 7093, LOV, Observatoire océanographique, F-06234, Villefranche/Mer, France

Abstract

The experiments made for the projet DYCOMED permit a better understanding of the natural organic matter (NOM) variation in seawater from surface to 2200m depth profile. Bisides the dissolved organic carbone (DOC) concentration, the NOM fluorescence gives an additional explication in sight of this particular ecosystem. The fluorescence data have been analyzed by the mathematic method PARAFAC. Four fluorescent NOM components have been found and have been compared.

Keywords: Organic Matter, Analytical Methods, Deep Sea Processes, Deep Waters

Introduction

As a semi-enclosed sea which presents a particular aquatic ecosystem, the Mediterranean Sea is a special reservoir of dissolved organic matter (DOM). Following the study of B.Avril (2002)[1], a periodic series of samplings have been performed during one year (2008) in the central Ligurian Sea (DYFAMED site, 43°25'N, 07°52'E, NW Mediterranean Sea).The samplings have been made at 12 depths every month from 0 to 2200m-depth. Unfiltered samples have been collected in precombusted glass bottles (particulate organic matter represents les than 2%) and conserved with sodium azide (NaN_3, 1M) to prevent any biological development.

Methodology

DOC measurements were made by High Temperature Catalytic Oxidation Technique (Shimadzu TOC-V). The Excitation and Emission Matrix (EEM) spectra were obtained by spectrofluorimetry (HITACHI 4500) at excitation wavelengths from 250 to 500nm and emission wavelengths from 200 to 550nm, both wavelength slits for 5nm, scan speed is 2400nm/min. Analysis of fluorescent dissolved organic matter (FDOM) in the depth profile has been done with the help of parallel factors analysis (PARAFAC) software. It is a powerful statistical technique to treat the 3D-fluorescence spectra leading to the decomposition by a number of independent fluorescent compounds. In order to treat the Inner Filter Effect (IFE), 119 EEM of diluted samples have been made besides of 119 EEM spectra of original samples[2,3,4].

Results and Discussion

Two data treatments have been taken for this project according to the presence of FDOM components in the different depths. Treatment of all sample spectrums from the depth 0 to 2200m-depth gives 4 fluorescent components (Fig.1) that represent the fluorescence maxima of previously identified moieties : [Tyr] maximal excitation wavelength and emission wavelength 265nm/305nm (tyrosine-like) ; [Trp] maximal $\lambda_{EX}/\lambda_{EM}$ =280nm/340nm (Peak T, tryptophan-like group); [M] maximal $\lambda_{EX}/\lambda_{EM}$=295nm/410nm (Peak M, marine humic-like substance) and a double maximum component [CA] with maximal $\lambda_{EX}/\lambda_{EM}$=335nm/445nm (Peak C, visible humic-like group) and $\lambda_{EX}/\lambda_{EM}$ = 250nm/445nm (Peak A, UV humic-like substance).

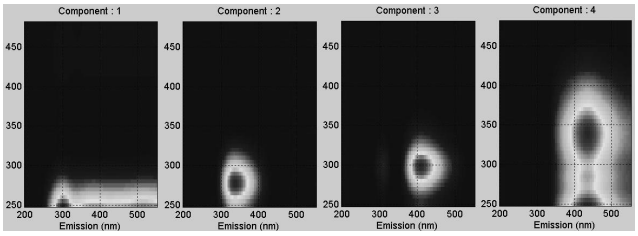


Fig. 1. 4 Components: Component 1, Tyrosine-like fluorophore; Component 2, Peak T-Tryptophane-like fluorophore; Component 3, Peak M-Known as marine humic-like substances fluorophore; Component 4, Peak C and A-coupled humic-like substances fluorophore.

Fluorescence contribution of each component at different logarithmic depths (Fig. 2a) shows that the most concentrated fluorophores zone is deeper than 100m throughout the year, which is different from the results of DOC concentration of which the most concentrated zone is on the seasurface[1]. It makes clearer the difference between living organism moleculars and NOM because of the probable existence of some less or no-fluorescent substance (huge moleculars or longer chained protein, etc.) in the surface waters and more fluorescent substances like NOM in the deeper sea. This might be owed to 3 reasons: the better recycling of NOM by living organisms thanks to the sun rays at the water surface than deep sea; the deposition of no-bioactive NOM towards to deeper seawaters; the influence of photo bleaching on chromophoric compounds to the presence of FNOM. The fluorescence contribution of protein substances (Tyr and Trp) is important (+ and O, Fig.2a), this could be due to unfiltered sampling protocol. Humic-like substances are generally less fluorescent comparing to other compounds, particularly the M compound. An important peak contribution of marine humic-like substance has appeared in May at the depth from 100m to 2200m, although the other fluorophores kept their values reasonable. Moreover, the intensity maxima was associated to the mosopelagic layer (100~400m), while an increase of protein substances in the deep sea occured at 400 m followed by a sharp decrease at 600 m in July, August and September. This is probably due to the thermal stratification of water column. In the intensity comparison among minima, averages and maxima (Fig.2b), we have observed the averages close to the minimal data, which signifies generally the low NOM concentration throughout the year, besides of period of meosotrophy (spring bloom). In the deep sea, there is normally less NOM concentration because of lysis and low carbon production. But occassionally, an increase of FNOM is observed for a reason not yet explained, estimated could be brong by deep current (the third compound in Fig.2b). This project will be continued for several years. It permits us to study the variation of an ecosystem in a 2200m depth oceanic water column.

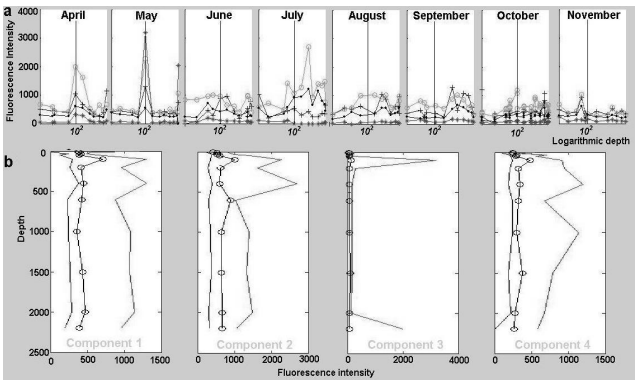


Fig. 2. Comparison of 4 components in depth profile. a): 4 components in each illusion with sea depths at Axis X and fluorescence intensity at Axis Y, totally 8 months from April to November. b): Fluorescence Minimal, Average and Maximal intensity in each illusion standing for each component.

References

1 - Avril B., 2002. DOC dynamics in the northwestern Mediterranean Sea (DYFAMED site). *Deep-Sea Res. pt. II*, 49: 2163-2183.

2 - Bro R. and Kiers H.A.L., 2003. A new efficient method for determining the number of components in PARAFAC models. *J. Chemomet.*, 17 : 274-286

3 - Luciani X. et al., 2008. Tracing of DOM from the SEPETIBABay by PARAFAC analysis. *Mar. Environ. Res.*, 65:148-157

PARAFAC TREATMENT IN 3D-FQ OF DOM-[M] COMPLEXATION

Huiyu Zhao [1]*, Roland Redon [1], Cedric Garnier [1] and Stephane Mounier [1]
[1] Laboratoire PROTEE-Bt R, USTV 83957 La GARDE Cedex - hzhao@univ-tln.fr

Abstract
The DOM-Metal complexation propriety is accessible by fluorescence quenching (FQ). FQ spectrum can determine the fluorescent DOM composition by parallel factor analysis (PARAFAC) with excitation-emission matrix (EEM). [Cu^{2+}] titration onto a river water sample from Brésil: [C] =5mg/L, initial [Cu^{2+}]=1.68 nM , pH=4.5, [Cu^{2+}]=10^{-9}M~10^{-3}M is done with 50 Excitation and Emission Matrix (EEM) analyzed by PARAFAC, which has extracted 2 fluorescent components from all EEM: C1 (λex=235nm/λem=420-425nm) and C2 (λex=250-260nm and 345-355nm/λem=470-480nm) of which corresponding interatures were obtained by this new approach. It is confirmed that with PARAFAC FQ modification values fluorophores are better distinguished from the whole matrix.
Keywords: Organic Matter, Metals, Analytical Methods, Chemical Analysis, Surface Waters

Introduction

Dissolved Organic Matter (DOM) is a compled mixture existing everywhere in the environment. The studies of DOM in aquatic ecosystems enable us to obtain some information on its coming future and the importance of its role in the bio-geochemical processes. The fluorescence technique makes analyzes possible on the basis of the optical propriety of the DOM including its fluorophores composition and its complexation propriety face to face to certain metal[1]. Recently for luminescence spectrum it is possible to determine the fluorescent component composition by the statistical analysis of parallel factor analysis (PARAFAC) with excitation-emission matrix (EEM)[2].

Methodology

The complexation propriety between DOM and metals is accessible by measuring the fluorescence quenching (FQ) functional to the metal additions. The EEMs in the FQ experiments contain maximal information as a whole of fluorescent DOM (FDOM). This work presents a quenching experience brought from copper ions titration onto a river water sample from Brésil of 5mg/L carbon concentration and 1.68 nano-molaire initial copper ions concentration (pH=4.5). A titration of copper ions ($Cu(NO_3)_2$) has been applied in copper-ions concentration range from 10^{-9}M to 10^{-3}M. Fifty EEM were obtained and gathered in order to analyze the FQ by PARAFAC. This statistical treatment permits us to extract 2 fluorescent components from the whole EEM (Fig.1): C1 (λex=235nm/λem=420-425nm) and C2 (λex=250-260nm and 345-355nm/λem=470-480nm) corresponding to the peaks already described in the literature.

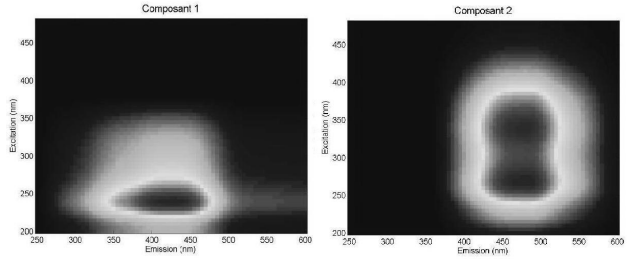


Fig. 1. Component 1 and Component 2 found by PARAFAC

Results and Discussion

Using the participation to the total fluorescence of these peaks, we have observed clearly that the fluorescence diminution was not uniform. The Fig.2 shows the relation between the Fluorescence Intensity Percentages (FI%)on function of logarithmic copper concentration (log[Cu]). The experimental points of Component 1 (C1, rhombus) show a stability near 100% at the begging of the copper ion titration just like those of Component 2 (C2, square) till to 10^{-7}mol/L. From this concentration, the C1 FI% continues decrease till to the end of titraton. But instead of decreation, the C2 FI% increases sharply from 90% to 170%, which dues probablly to the Inner Filter Effect[3] (While NOM concentrated in a sample, some of moleculars absorb the energy emitted by others, which shuts down the observed fluorescent light. This phenomenon is called "Inner Filter Effect", IFE)[3]. The current methods to correct IFE are unuseful in these continuous experimental measurements, although an other correcting idea is putting in the future trying. Anyway, C2 has shown its great fluorescent quenching characters by complexing with metal. The analysis of complexation propriety has found out two complexation compounds values: $K_1=10^{4.6}$; $L_1=10^{-7.8}$ et $K_2=10^{4.46}$; $L_2=10^{-9}$ all for the component C2 (Fig. 1). These results signifies at least 2 complexation compounds giving by a same EEM component. The utilisation of PARAFAC has confirmed the presence of just 2 fluorescence fluorophores but more than 3 complexing sites obeying to the treatment conditions given by Ryan and Weber[4]. Meanwhile, PARAFAC permits to better observe the FQ values' modifications by decomposition of fluorophores contribution from a whole matrix. That is why C2 contains 2 peaks identified: Peak C and Peak A[5]. No fluorophore no-affected by the copper titration has been detected.

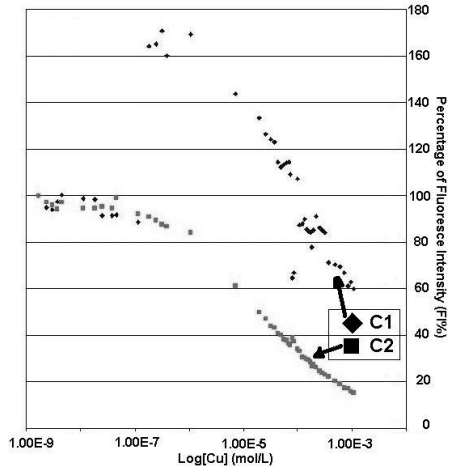


Fig. 2. Relation between fluorescence intensity and logarithmical copper ions concentration (FI%/log [Cu^{2+}])

This new coupled approach organizing the optical fluorescence measurements (FQ), the mathematical data analysis (PARAFAC) and informatical modeling method (PROCESE) permits us to observe a macro image on FNOM composition and to link it to its own micro complexation characters. Application of this approach to mditerranean samples will be in the coming work.

References

1 - Cabaniss S.E. and Shuman M. S., 1988. Copper binding by dissolved organic matter: I.SuwanneeRiver fulvic acid equilibria. *Geochim. Cosmochim. Ac.*, 52: 185-193

2 - Murphy K. R., Stedmon C. A., Waite T. D. and Ruiz G. M., 2008. Distinguishing between terrestrial and autochthonous organic matter sources in marine environments using fluorescence spectroscopy. *Mar. Chem.*, 108: 40-58

3 - Luciani X. et al., 2009. A simple correction method of inner filter effects affecting FEEM and its application to the PARAFAC decomposition. *Chemometr. Intell. Lab.*, 96: 227-238

4 - Ryan D. K. and Weber J. H., 1982. Fluorescence quenching titration for determination of complexing capacities and stability constant of fulvic acid. *Anal. Chem.*, 54(6): 986-990

5 - Coble P. G., 1996. Characterization of marine and terrestrial DOM in seawater using excitation-emission matrix spectroscopy. *Mar. Chem.*, 51: 325-346

DISTRIBUTION AND ANTIBIOTIC RESISTANCE OF HETEROTROPHIC AND INDICATOR BACTERIA IN THE COASTAL AREAS OF TURKEY, SYRIA AND LEBANON

G. Altug [1]*, M. Cardak [2], P. S Ciftci [1], S. Gurun [1], A. A. Saad [3], A. Ibrahim [4] and M. Fakhri [5]
[1] Istanbul University, Faculty of Fisheries, Department of Marine Biology, Istanbul, Turkey - galtug@istanbul.edu.tr
[2] Canakkale Onsekiz Mart Universiry, Faculty of Fisheries, Canakkale, Turkey
[3] Tishreen University, Faculty of Agriculture, Lattakia, Syria
[4] High Institute of Marine Research Syria
[5] National Centre for Marine Sciences Lebanon

Abstract
The levels of indicator and heterotrophic bacteria (HPC) and the frequency of antibiotic resistant bacteria with respect to the areas from which they were isolated were investigated and compared in the sea water samples taken from the coastal area of the Eastern Mediterranean (Turkey, Syria, Lebanon) and the offshore area (Northern Aegean Sea). While the highest levels of resistant bacteria were found in the samples taken from Syria, the lowest level of resistant bacteria was found in the samples taken from the offshore area of the Northern Aegean Sea.
Keywords: Bio-Indicators, Bacteria, Eastern Mediterranean

Introduction
In this study, bacterial studies were conducted with an aim to detect the level of indicator and heterotrophic bacteria and compare the level of antibiotic resistant strains in the coastal areas between Cesme and Cevlik (Turkey), Lattakia (Syria) and Beirut (Lebanon) and also the offshore area extending from the eastern part of Andros Island to the southern part of Gokceada -Thasos Island.

Material and methods
Two cruises were conducted with R/V YUNUS-S and sea water samples were collected during the months of August in 2007 and 2008 (Fig 1). Indicator bacteria analyses using the membrane filtration method [1] and HPC analyses using spread plate method with Marine Agar were carried out. Antibiotic resistance analyses were done according to NCCLS [2].



Fig. 1. Study Area

Results and Discussion
Faecal coliform, total coliform and HPC were found to be between<1,0–1,0 $\log_{10}$ CFU/100 ml, <1,0–2,1 $\log_{10}$ CFU/100 ml, 5,4–7,1 $\log_{10}$ CFU/100 ml, respectively at 15 stations, during August 2007, in the Aegean offshore area ranging from the eastern part of Andros Island to the southern part of Gokceada-Thasos Island. Also in 2007, results of analyses conducted at 97 points between Cesme and Cevlik in the Eastern Mediterranean coastal area of Turkey were found to be between 1,7-4,7 $\log_{10}$ CFU/100 ml for faecal coliform, 1,8-6,9 $\log_{10}$ CFU/100 ml for total coliform, and 5,5-8,8 $\log_{10}$ CFU/100 ml for HPC. Again in 2008, results of analyses conducted at 90 points between Cesme and Cevlik in the Eastern Mediterranean coastal area of Turkey were found to be slightly lower than in 2007. In 2007, results of analyses conducted at 6 points along the coastal area of Syria were found to be between 2,5-3,7 $\log_{10}$ CFU/100 ml for faecal coliform, 3,1-4,5 $\log_{10}$ CFU/100 ml for total coliform, and 5,5-6,6 $\log_{10}$ CFU/100 ml for HPC. Once more in 2008, results of analyses conducted at 6 points along the coastal area of Syria were found to be slightly higher than in 2007 (2,7-3,8 $\log_{10}$ CFU/100 ml for faecal coliform, 2,9-4,1 $\log_{10}$ CFU/100 ml for total coliform, and 5,8-6,2 $\log_{10}$ CFU/100 ml for HPC). Also in the year 2008, results of analyses conducted at 5 points along the coastal area of Lebanon were found to be between 1,0 -3,2 $\log_{10}$ CFU/100 ml for faecal coliform, 1,9-5,2 $\log_{10}$ CFU/100 ml for total coliform, and 5,5-7,8 $\log_{10}$ CFU/100 ml for HPC.

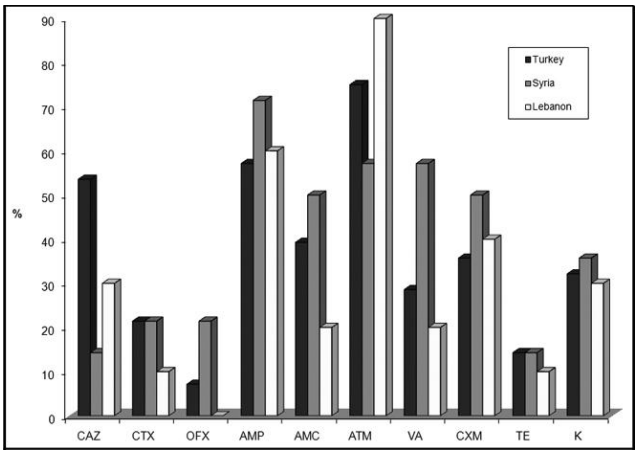


Fig. 2. Distribution of Antibiotic Resistant Strains

While the highest Multiple Antibiotic Resistance (MAR) was found in the bacteria isolated from the coastal area of Syria (48%), the bacteria isolated from Turkey (38%) and Lebanon (31%) respectively followed it. The bacteria isolated from the offshore area of the Northern Aegean Sea did not show resistance against antibiotics. The antibiotic derivates which were found to be resistant to bacteria were different in different regions. This situation shows that pollution input and the usage rate of antibiotics have differences related to geographic regions. In this study the first comparative bacterial data were obtained for these regions. There is a need for international long term monitoring studies for the purpose of detecting point pollution in these areas.

Acknowledgements We would like to thank Prof. Dr. Bayram OZTURK who contributed to our study by coordinating the cruises, and the crew of the R/V YUNUS-S.

References
1 - APHA., 2000. Standard Methods for the Examination of Water and Wastewater 20th Edition, *In:* Clesceri, L.S., A.E Greenberg and A.D Eaton (eds), *American Public Health Association, American Water Works Association and Water Environment Federation*. Washington, D.C.
2 - National Comittee for Clinical Laboratory Standards., 1999. (NCCLS) Performance standards for antimicrobial susceptibility testing, Ninth Informational Supplement, M100-S9, Wayne.

DISTRIBUTION OF NUTRIENTS AND CHLOROPHYLL-A IN THE COASTAL AREA OF THE BOSPHORUS (TURKEY)

Neslihan Balkis [1]*, Yelda Aktan [2] and Nuray Balkis [3]
[1] Istanbul University, Faculty of Science, Department of Biology - neslbalk@istanbul.edu.tr
[2] Istanbul University Fisheries Faculty
[3] Istanbul University, Institute of Marine Science and Management

Abstract
The aim of this paper was to establish the annual variations in nutrient and chlorophyll-a concentrations. Samples were collected from June 2003 to May 2004 at five stations in the coastal waters of the Bosphorus. Nitrate+nitrite, phosphate and silicate concentrations in winter were higher than other sampling periods. Chlorophyll-a concentrations ranged between 0.54 and 6.13 µg l .
Keywords: Nutrients, Chlorophyll-a, Bosphorus

The Bosphorus is located at the northern part of the Turkish Straits System [1]. It is a narrow natural channel carrying the highly polluted waters of the Black Sea to the Sea of Marmara. Its upper layer waters have an average salinity of 16.5-18.5 ppt, and the lower layer an average salinity of 38 ppt. Such conditions are very likely to create density currents that can strongly affect the biogeochemical cycle of the system [2]. Nutrients are the essential chemical components of life in the marine environment. Phosphorus and nitrogen are incorporated into living tissues, and silicon is necessary for the formation of the skeletons of diatoms and radiolaria [1]. In the sea, most of the nutrients are present in sufficient concentration, and the lack of some of them limits the growth of phytoplankton [3]. The studies on this subject in the Bosphorus are still very limited. The aim of this paper was to establish the annual variations in nutrient and chlorophyll-a concentrations. This study was carried out in the coastal waters of the Bosphorus at five stations between June 2003 and May 2004 (Fig. 1). Nitrate+nitrite (NO3+NO2-N) concentrations were analyzed by cadmium reduction method on a Skalar autoanalyser [4]. Phosphate (PO4-P), silicate (SiO4-Si) and chlorophyll-a analyses were detected by the methods described by Parsons et al. [5].

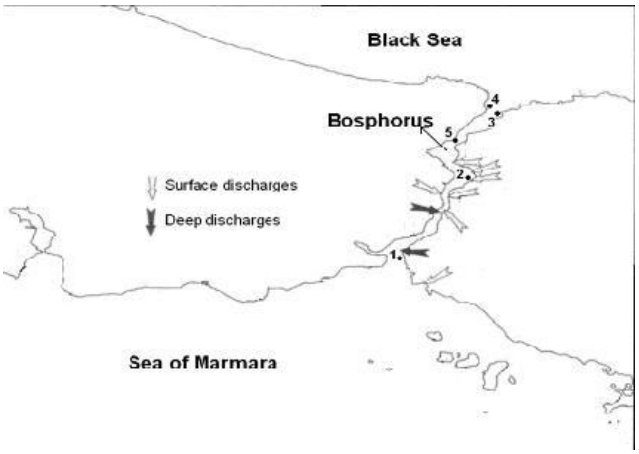


Fig. 1. Research stations in the Bosphorus

Nutrient and chlorophyll-a concentrations are shown in Table 1. The amounts of nitrate+nitrite, phosphate and silicate were 0.26 (November)-42.50 µg-at l-1 (January), 0.24 (September)-7 µg-at l-1 (December) and 1.97 (January)-84.26 µg-at l-1 (December), respectively. Chlorophyll-a concentrations, as an indicator of phytoplankton biomass, ranged between 0.54 (September) and 6.13 µg l-1 (November).

In the present study, nutrient levels in winter period were generally higher than those in spring, summer and autumn. Especially, the highest values were recorded in the untreated domestic waste water discharge point. As Balkis [6] pointed out, there is an increase with time nutrient concentration of the Bosphorus. According to chlorophyll-a based assessments [7], chl-a values in this study showed that the area is generally eutrophic in nature.

Tab. 1. Variations of nutrient and chlorophyll-a concentrations at the research stations

	NO_2+NO_3-N (µg-at l^{-1})			
	Summer	Autumn	Winter	Spring
Stations	Min-Max	Min-Max	Min-Max	Min-Max
1	2.31-6.72	2.23-4.50	3.47-7.37	2.95-3.96
2	3.21-4.69	1.09-3.69	1.21-4.33	2.15-2.96
3	0.71-1.12	0.26-1.52	0.85-1.90	0.73-0.97
4	0.96-2.23	0.85-10.76	6.11-42.50	8.66-9.66
5	2.55-4.87	2.04-10.93	5.25-37.76	21.15-27.3
	PO_4-P (µg-at l^{-1})			
	Summer	Autumn	Winter	Spring
Stations	Min-Max	Min-Max	Min-Max	Min-Max
1	0.61-1.01	0.45-0.49	0.27-0.55	0.25-0.33
2	1.14-3.04	0.53-1.26	0.36-0.41	0.31-0.46
3	0.28-0.32	0.24-0.32	0.27-0.36	0.16-0.33
4	0.28-0.41	0.24-1.26	0.91-4.05	0.55-0.85
5	0.97-1.58	0.61-2.96	5.00-7.00	3.85-4.61
	SiO_4-Si (µg-at l^{-1})			
	Summer	Autumn	Winter	Spring
Stations	Min-Max	Min-Max	Min-Max	Min-Max
1	8.93-12.09	8.93-12.64	2.95-5.17	2.61-3.01
2	4.94-8.79	5.49-7.83	4.55-7.63	3.84-3.97
3	9.07-15.38	7.42-8.52	1.97-14.88	11.21-12.15
4	3.30-14.29	4.94-20.05	26.69-84.26	16.41-21.17
5	7.69-16.48	9.48-21.29	6.89-53.26	33.44-41.10
	Chl-a (µg l^{-1})			
	Summer	Autumn	Winter	Spring
Stations	Min-Max	Min-Max	Min-Max	Min-Max
1	3.35-4.11	1.10-1.77	1.17-5.48	1.56-2.01
2	0.88-1.67	0.99-1.45	1.22-4.85	1.09-1.88
3	0.88-1.92	0.54-6.13	1.44-5.56	1.05-1.78
4	1.56-1.99	1.10-2.58	1.32-5.55	1.63-3.49
5	1.21-2.19	0.90-3.57	1.00-2.44	1.12-1.63

Acknowledgements : This work was supported by the Research Fund of Istanbul University, project numbers 111/15052003.

References
1 - Bastürk Ö., Saydam A.C., Salihoglu I. and Yilmaz A., 1986. Oceanography of the Turkish Straits', *First Annual Report*, Vol. III: health of Turkish Straits, II. Chemical and environmental aspects of the Sea of Marmara. Institute of Marine Sciences, METU, Erdemli-Içel, Turkey.
2 - Oguz T., Özsoy E., Latif M.A., Sur H.I. and Ünlüata Ü., 1990. Modeling of hydraulically controlled Exchange flow in the Bosphorus Strait. *J. Phy. Oce*., 20: 945-965.
3 - Pojed I. and Kveder S., 1977. Investigation of nutrient limitation of phytoplankton production in the Northern Adriatic by enrichment experiments. *Thalassia Jugoslavica*, 13: 13-24.
4 - American Public Health Association (APHA), 1999. Standard Methods for the Examination of Water and Waste Water 20th ed., Washington DC, USA.
5 - Parsons T.R., Maita Y. and Lalli C.M., 1984. A manual of chemical and biological methods for seawater analysis. Pergamon Press, U. K
6 - Balkis N., 2007. Variations of nutrients and chlorophyll-a in the coastal area of Baltalimani (Bosphorus-Turkey). *Fresenius Environmental Bulletin*, 16: 1429-1434.
7 - Ignatiades L., 2005. Scaling the trophic status of the Aegean Sea, eastern Mediterranean. *Journal of Sea Research*, 54: 51-57.

FIRST RECORD OF *OSTREOPSIS OVATA* BLOOM IN THE GULF OF TRIESTE (NORTHERN ADRIATIC SEA)

O. Blasutto [1]*, M. Celio [1], B. Zanolin [1], C. Suraci [1], M. Venuti [1], A. Acquavita [1] and G. Mattassi [1]
[1] Regional Environmental Protection Agency - ARPA-FVG - oriana.blasutto@arpa.fvg.it

Abstract
In a shallow tidal pool in the Gulf of Trieste the first observed bloom of *O. ovata* occurred in September-October 2009. Water samples were collected for the light microscope analyses and nutrient analyses. Hydrological data were recorded using a multiparametric probe. *O. ovata* was observed by epifluorescent light microscope. Cell abundance was higher than 3 million cells per liter.
Keywords: Adriatic Sea, Dinoflagellates, Toxic Blooms

Introduction
O. ovata is an epiphytic potentially toxic dinoflagellate ([1] and references therein). Some *Ostreopsis* species can produce palytoxin that can accumulate in the trophic web, thus representing a potential although so far undefined sanitary risk [2]. Recently, *Ostreopsis* spp. produced blooms in the Tyrrhenian and southern Adriatic Sea. These blooms have been related to human health problems [3]. Monti et al. (2007) report the first record of *O.* cfr. *ovata* in the Gulf of Trieste and close to the town of Rovinj (Croatia) in October 2006. Up to summer 2009 in the Gulf of Trieste we have not been aware of any bloom in the water column though the presence of this dinoflagellate has been revealed by ARPA-FVG in several shallow coastal sites of the gulf (Bulletins of the Institute for Environmental Protection and Research - ISPRA). From June 2009 to July 2009 ARPA-FVG carried out a study in the Gulf of Trieste in order to investigate the hydrological and biological characteristics of the marine coastal water in relation to the presence of this potentially toxic microalgae. In early autumn the presence of a bloom of *O. ovata* was observed in a tidal pool in the coastal zone of the gulf. During this event some water samples were collected in order to study the composition and the abundance of the microalgal community and nutrient composition. Hydrological parameters were collected as well.

Material and Methods
On 29th September, 01st and 07th October 2009 water samples were collected in a tidal pool in the Gulf of Trieste. During sampling temperature, salinity and dissolved oxygen values were recorded using a multiparametric Idronaut mod. 316 probe. The hydrological data have been submitted to a quality control. Nutrients analyses were performed colorimetrically for ammonium, silicate, phosphate, nitrate and nitrite using standard autoanalyzer techniques [4]. The composition and the abundance of the microalgal community were analyzed following UNI EN 15204 (2006) [5].

Results and Discussion
From the onset of *O. ovata* in the Gulf of Trieste the coastal area most affected by the presence of this species has been a coastal zone known as Canovella De'Zoppoli (Duino-Aurisina). This area is characterized by the presence of a tidal pool well demarcated from the rest of the beach and in contact with the open sea only during high tide. The tidal pool is characterized by a pebbly bottom and it is sheltered from wind blowing and from wave actions by a natural reef; its depth ranges between 0.2 and 1.5 m. Macroalgae are almost absent. During the microalgal bloom a mucilaginous brown pellet coated all the pebbly bottom and some brown macro-aggregates were floating on the water surface. Water surface temperature was 22.3°C and dissolved oxygen reached 142% of saturation. The high values of oxygen saturation were probably due to the elevated photosynthetic activity of the microalgal community. The microscopic analyses revealed the prevalence of *O. ovata*. The highest abundance of the dinoflagellate was 3076416 cells per liter in the water in contact with the pebbles previously rubbed, 2636928 cells per liter in the surface water of the tidal pool and 46800 cells per liter in the surface water picked up in a small dock adjacent to the tidal pool. The geomorphological characteristic of the tidal pool, its sheltered position from the wind and wave action, together with the good weather conditions with windless and cloudless sky that occurred for a period before the appearance of the bloom, have probably supported the development of *O. ovata* that found in this site the ideal conditions for its proliferation. As soon as weather conditions changed the bloom abruptly decreased. Fortunately swimmers usually attend the surrounding areas and very little this one affected by the phenomenon and thus the health risk appears to be reduced. Mussel culture are more than 200 m away from the site and sampling at the water column near the culture have detected insignificant abundance of *O. ovata*. Notwithstanding the site will be monitored in the future considering carefully the health aspect.

References
1 - Monti M., Minocci M., Beran A. and Iveša L., 2007. First record of *Ostreopsis* cfr. *Ovata* on macroalgae in the Northern Adriatic Sea. *Mar. Poll. Bull*., 54: 598-601(scientific article).
2 - Barone R., 2007. Behavioral trait of *Ostreopsis ovata* (Dinophyceae) in Mediterranean rock pools: the spider's strategy. *Harmful Algae News*, 33: 1-3 (scientific article).
3 - Sansoni G., Borghini B., Camici G., Casotti M., Righini P. and Fustighi C., 2003. Fioriture algali di *Ostreopsis ovata* (Gonyaulacales: Dinophyceae): un problema emergente. *Biologia Ambientale*, 17(1): 17-23 (scientific article).
4 - Parsons T.R., Maita Y. and Lalli C.M., 1984. A manual of chemical and biological methods for seawater analysis. Pergamon, New York (book chapter).
5 - UNI EN 15204, 2006. Water Quality. Guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermohl technique), 42 pages (book chapter).

SURVIVAL OF PATHOGENIC *ESCHERICHIA COLI* O55B5 IN BRACKISH WATER

I. Boukef [1]*, S. Mejri [1], N. Al Gallas [2], P. Got [3], R. Mraouna [1], R. Ben Aissa [2], A. Boudabous [4] and M. El Bour [1]
[1] Laboratoire de Microbiologie, Institut National des Sciences et Technologie de la Mer - imen.boukef@yahoo.fr
[2] Laboratoire de Contrôle des Eaux et Denrées Alimentaires, Institut Pasteur de Tunis, 1002 Belvédère, Tunisie
[3] Laboratoire Ecosystèmes Lagunaires, Université Montpellier 2, CNRS IFREMER UMR 5119 Place E. Bataillon, Case Courrier 093, 34095 Montpellier cedex 05, France.
[4] Laboratoire des Microorganismes et Biomolécules Actives, Faculté des Sciences de Tunis, Tunisie.

Abstract
Our study investigated survival and virulence of *Escherichia coli* O55:B5 incubated in brackish water microcosms (Bizerte lagoon, northern coast in Tunisia). Thus, Microcosms were exposed to natural sunlight or maintained in darkness. Results showed survival time prolonged for strain maintained in darkness with modifications in biochemical profiles. Virulence, studied using vero cell test, was maintained during brackish water survival.
Keywords: Bacteria, Brackish Water, Pathology

Introduction
Survival of enteric bacteria reviews pointed out solar radiation and osmotic stress as the most alteration factors of bacteria (Rozen and Belkin, 2001). Else, enteric bacteria survival in seawater depends on their ability to retain their virulence characteristics (Du et *al.*, 2007). Here we tried to test the survival of virulent enterobacteria.

Materiel and methods
A cell suspension of *E.coli* O55:B5, washed three times, inoculated in microcosms ($\approx 10^6$ cells mL^{-1}) during the period from 18 to 30 April, where microcosms were exposed to sunlight (12 days) or maintained in dark condition (21 days). The total number of cells (TC) and the altered cells (AC) were counted by using respectively the DAPI (4', 6-diamide-2-phenylindole-Sigma) and the Live/Dead® *Bac*Light™ kit. The virulence of *E.coli* was studied using the vero cell test (Al-Gallas et *al*., 2002).

Result and discussion
In light conditions experiment (Fig.1a), TC abundances decrease was not significant. By the end of 12th day, abundances were lower than 10cfu mL^{-1} on TSA agar and 1cfu mL^{-1} on DL agar. Else, the AC increased during at first of experiment and then stabilized. In darkness, TC abundances showed limited decrease (Fig.1b). Culturable counts decreased progressively and stabilized at a high level (10^5 cfu mL^{-1}) by the 9th day, with slow increase in abundance of AC until the 4th day. The membrane alteration process appeared to affect the *E.coli* strain in light and in darkness (lower fraction of cell population) conditions. Membrane alteration involved the degradation of several vital processes linked to the role of cytoplasmic membrane and depended mainly on sunlight intensity (Fiksdal and Tryland, 1999). Nevertheless, we noted limited changes in carbohydrates assimilation, for darkness experiments. *E.coli* conserved its capacity to survive in non-host environment which can give to virulent serotype a competitive advantage compared to other *E. coli* serotypes and may have severe consequences for human exposed to potential contamination through shellfish consumption.

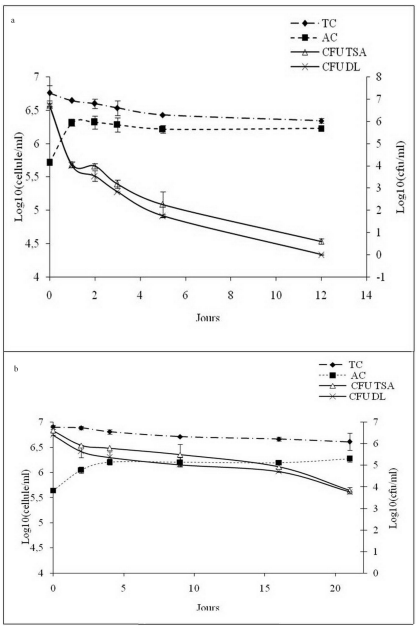


Fig. 1. Changes in culturable (CFU), total cell (TC) and altered cells (AC) of *E.coli* O55B5 exposed to sunlight (a) and in darkness (b). TSA: Trypcase-soy agar, DL: Desoxycholate Lactose agar

References
1 - Al-Gallas, N., Ben Aissa, R., Annabi, T.A., Bahri, O. and Boudabous, A., 2002. Isolation and characterization of shiga toxin-producing *Escherichia coli* from meat and dairy products. *Food Microbiol*., 77: 571-582.
2 - Du, M., Chen, L., Zhang, X., Li, A., Li, Y. and Wang, Y., 2007. Retention of virulence in a viable but nonculturable *Edwardsiella tarda* isolate. *Appl. Environ. Microbiol*., 73: 1349-1354.
3 - Fiksdal, L. and Tryland, I., 1999. Effect of U.V. light irradiation, starvation and heat on Escherichia coli *β*-D-galactosidase activity and other potential viability parameters. *J. Appl. Microbiol*., 87: 62-71.
4 - Rozen, Y. and Belkin, S., 2001. Survival of enteric bacteria in seawater. *Microbiol. Rev.*, 25: 513-529.

DEGRADATION OF HIGH MOLECULAR WEIGHT DISSOLVED ORGANIC MATTER BY DEEP-SEA PROKARYOTES ON PAP SITE (NORTHEASTERN ATLANTIC OCEAN)

Mehdi Boutrif [1]*, Marc Garel [1] and Christian Tamburini [1]
[1] LMGEM, UMR6117, Centre d'Océanologie de Marseille - mehdi.boutrif@univmed.fr

Abstract
The aim of this work is to evaluate the capacity of deep-sea prokaryotes to degrade HMWDOM on the Porcupine Abyssal Plain site (Northeastern Atlantic) under in situ conditions.
Keywords: Bacteria, Deep Sea Ecology, Organic Matter

Deep oceans represent one of the largest reservoirs of organic carbon on the biosphere, mainly in the form of dissolved organic matter (DOM). DOM can be divided in high molecular weight (HMW-DOM > 1000Da, representing between 15 and 35% of total DOM) and low molecular weight (LMW-DOM < 1000Da) size classes. Study of the biogeochemical cycle of DOM must be improved in order to understand the interactions between marine prokaryotes (Archaea and Bacteria) and marine organic matter, since they play a central role in aquatic carbon cycle.

We synthesized tritiated exopolysaccharides (^{3}H-EPS) [1] and incubated them with natural deep-sea prokaryotes (2000m) at *in situ* pressure and temperature conditions. We also examined the assimilation of ^{3}H-Glucose and measured Prokaryotic Heterotrophic Production (PHP, with ^{3}H-Leucine). The number of cells taking up tritiated Leucine, EPS and Glucose were determined using microautoradiography combined with catalyzed reporter deposition fluorescence in situ hybridization (MICRO-CARD-FISH).

The first results shown that deep-sea prokaryotes are able to degrade ^{3}H-EPS, assimilation rates being at the same range than in surface waters (assimilation measured between 1.6 and 2.81 pmol.L^{-1} h^{-1}). Using our high-pressure retaining system [2], we found significant differences in assimilation rates for all the substrates used between *in situ* and atmospheric pressure conditions. In fact, assimilation rates of EPS, Glucose and Leucine were, respectively, 3.6, 3.4 and 2.3 times higher on samples under *in situ* pressure conditions than decompressed one, confirming previous results obtained in Mediterranean Sea.

References
1 - Elifantz H., Malmstrom R.R, Cottrell M.T., Kirchman D.L., 2005. Assimilation of polysaccharides and glucose by major bacterial groups in the Delaware Estuary. *Applied and Environmental Microbiology.* 71: 7799-7809 (scientific article).

2 - Tamburini C., Garcin J. & Bianchi A., 2003. Role of deep-sea bacteria in organic matter mineralization and adaptation to hydrostatic pressure conditions in the NW Mediterranean Sea.*Aquatic Microbial Ecology*, 32 (3): 209-218 (scientific article).

FUNCTIONAL DIVERSITY OF PHYTOPLANKTON IN THE MEDITERRANEAN SEA: ENVIRONMENTAL FORCING ON CELL SIZE AND ECOPHYSIOLOGY

C. Brunet [1]*, V. Saggiomo [1], A. Basset [2], F. Conversano [1] and V. Giovagnetti [1]
[1] Stazione Zoologica Anton Dohrn - christophe.brunet@szn.it
[2] DisTeBa, University of Salento, Lecce, Italy

Abstract
Size is a crucial biological trait that determines the metabolism and energy fluxes in cells through resources requirement and acquisition, as well as the "susceptibility" of cells to environmental changes. The aim of our contribution is to do a synthesis of the relations between size – pico *vs* nano+microphytoplankton – and environmental forcings that have been investigated in different trophic conditions of the Mediterranean sea as well as from laboratory experiments. Different time and space scales are analyzed, from the large basin scale to mixed layer or deep-chlorophyll maximum. A strong discrimination between picoplankton and the rest of the community is highlighted both at the level of the ecological pattern and on their ecophysiological behavior.
Keywords: Phytoplankton, Pigments, Physiology, Biodiversity, Primary Production

Phytoplankton size ranges between 0.3 and more than 100 µm, classified as picoplankton (<2-3µm), nanoplankton (3<20µm) and microplankton (>20µm). Body size is a key-parameter in community ecology and probably the most impacting functional trait for phytoplankton ecology. Both size and ecophysiological diversity could have their relevance in the paradox of plankton [1]. This adaptative character determines the efficiency of the algal community function - as photosynthesis [2] - and the food web structure. At a functional level, the broad range of sizes – resulting from adaptative evolution - determines a high diversity of behaviors and acclimative responses to environment forcing [3] and its variability over different scales. Tackling with the question of cell size community structure means to deal with the relation between ecosystem and cells at an energetic level [4]. The aim of our contribution is to investigate the relations between phytoplankton size community structure and environmental properties using a (photo-) physiological approach. The questions we address are: How does size affect the eco-photophysiological strategy developed by cells? and in which way does the size-related strategy fit with the environmental properties and variations? Data we are dealing with come from (i) experimental laboratory studies aiming to investigate the photoacclimation capacities relatively to light changes and the role of cell size on algal responses [3, 5] , and (ii) from the Mediterranean sea field. The data we are analyzing cover a broad range of trophic states and relevant scales for phytoplankton ecology, from the large basin scale to the vertical distribution over the water column with emphasis on mixed layer and deep-chlorophyll maximum. Data has been collected during a trans-Mediterranean cruise carried out in summer 2007, mesoscale studies performed in the NorthWestern Mediterranean sea (spring 2003), Northern Adriatic sea (June 2003) and Strait of Sicily (1996) as well as from a seasonally sampled fixed station in the South Tyrrhenian sea (2006-2009) and over a daily cycle sampling program. Analysis mainly regards size-fractionated pigments (pico *vs*. nano+microphytoplankton), primary productivity, hydrological and light environment and nutrient concentrations. Contribution of picoplankton varied along trophic gradients over all the investigated scales. Our results highlight significant differences of ecological behavior between the two algal size classes (pico and rest of the community). Picoplankton cells are no- or little limited by nutrient concentrations and these cells appear to be much more able to cope with infra-diel light variations than the greater cell size. That means that photosynthetic function is strongly related to light field in the picoplankton group relatively to the greater cell size. Ecological implications are that picoplankton distribution would be mainly influenced by light (quantity and variability) and that is able to occupy niches characterized by relatively high stressful conditions, in relation to strong adaptation to these niches.

References
1 - Hutchinson G.E., 1961. The paradox of the plankton. *The American Naturalist,*XCV (882): 137-145.
2 - Finkel Z., 2001. Light absorption and size scaling of light-limited metabolism in marine diatoms. *Limnol. Oceanogr.*, 46: 86-94.
3 - Dimier C., Saviello G., Tramontano F. and Brunet C., 2009. Comparative ecophysiology of the xanthophyll cycle in six marine phytoplanktonic species. *Protist*, 160: 397-411.
4 - Litchman E., Klausmeier C.A., Schofield O.M. and Falkowski P.G., 2007. The role of functional traits and trade-offs in structuring phytoplankton communitites: scaling from cellular to ecosystem level. *Ecology Letters*, 10: 1170-1181.
5 - Dimier C., Brunet C., Geider R. and Raven J., 2009. Growth and photoregulation dynamics of the picoeukaryote *Pelagomonas calceolata* in fluctuating light. *Limnol. Oceanogr.*, 54: 823-836.

SEASONALITY OF DINOFLAGELLATES IN OLIGOTROPHIC ECOSYSTEM OF MIDDLE ADRIATIC

Marijeta Calic [1]*, Marina Caric [1] and Nenad Jasprica [1]
[1] Institute for Marine and Coastal Research - marijeta.calic@unidu.hr

Abstract
This study presents the first data on dinoflagellates composition in oligotrophic Telašcica Bay, and it is a part of complex hydrographical and biological investigation in the Middle Adriatic during 1999-2000. The relative contribution of dinoflagellates to microphytoplankton varied from 0 to 99.18%. Dinoflagellates dominated phytoplankton from late spring to beginning of autumn when water temperatures over 20 °C prevailed.
Keywords: Adriatic Sea, Dinoflagellates, Salinity, Temperature

Introduction
Telašcica Bay is situated in the central part of the eastern Adriatic coast, in the SE part of the island of Dugi Otok. It is 8200 m long and 150-1500 m wide, with the total coast length of 68.78 km. Owing to well-indented coastline and specific and diverse plant and animal life, this area was proclaimed the Nature Park in 1988. Based on the annual microphytoplankton abundance, Telašcica Bay may be classified as oligotrophic ecosystem [1].

Materials and methods
Phytoplankton samples were collected and hydrographic parameters were measured monthly between November 1999 and October 2000 in Telašcica Bay (except in February 2000). Surface samples were collected at three stations: inland (T1), middle (T2), and outer (T3). Temperature, salinity and oxygen saturation were calculated using standard oceanographic methods [2]. Phytoplankton counts were obtained at 200x and 400x magnification, using the inverted microscope method [3]. PRIMER v5 software was used to calculate the Margalef's species richness index [4].

Results
Water temperature in Telašcica Bay ranged from 10.3 °C (January) to 24.9 °C (July), with both the maximum and minimum at T1 (Fig. 1). Temperature rose from April to July and began to fall down in September at all tree stations. Salinity ranged from 37.9 in May to 38.9 in December, both at T2 (Fig. 1). Dissolved oxygen concentrations ranged from 4.9 cm^3 L^{-1} in September at T3 to 6.4 cm^3 L^{-1} in June at T2 (Fig. 1).

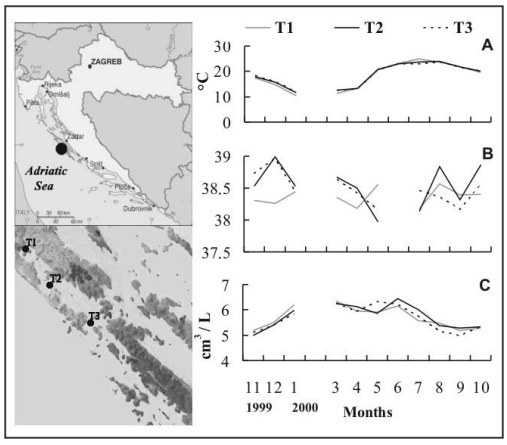


Fig. 1. Map of Telašcica Bay (left) and annual distribution (right) of surface temperature (A), salinity (B) and dissolved oxygen (C)

Microphytoplankton (MICRO, cells size > 20 µm) abundances, varied from 1.2 x 10^3 cells L^{-1} in September at T3 to 2.5 x 10^4 cells L^{-1} in April at T1. Dinoflagellates were present in the Telašcica Bay throughout the whole investigating period, except in November at T2 (Fig. 2). The relative contribution of dinoflagellates to MICRO varied from 0 to 99.18% and from May to September they were the dominant group in MICRO at all investigated stations. Abundance of dinoflagellates ranged from 0 to 2.08 x 10^4 cells L^{-1} (Fig. 2), with the highest abundance encountered at station T2 (June2000).

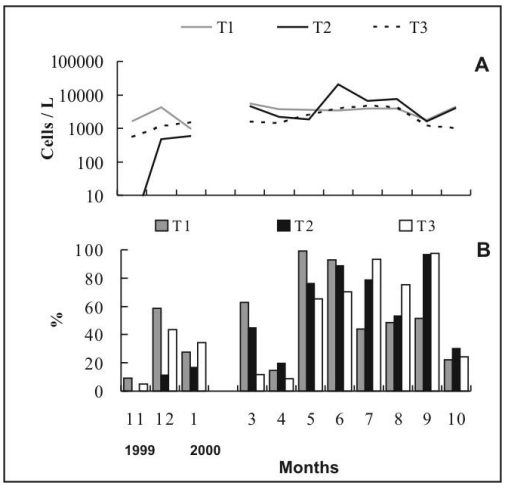


Fig. 2. Annual distribution of dinoflagellates abundances (A) and their relative contribution to microphytoplankton (B)

Altogether, 59 taxa of dinoflagellates were identified in Telašcica Bay. The most abundant taxa (> 10^3 cells L^{-1}) were: *Gymnodinium* spp., *Gyrodinium* sp., *Oxytoxum variabile*, *Prorocentrum compressum, Prorocentrum micans, Prorocentrum minimum*, *Prorocentrum triestinum*, *Scrippsiella* sp. and unidentified dinoflagellates. *Prorocentrum compressum* was the most dominant species during the peak in June (1.7 x 10^4 cells L^{-1}) . Margalef's species richness index varied from 0 to 3.6 at all stations, with the highest value found at the station T2 in August.

Conclusion
Dinoflagellates dominated the surface phytoplankton from late spring until beginning of autumn, when temperatures higher than 20 °C prevailed in the Telašcica Bay. In these months the contribution of dinoflagellates to total MICRO was 48-99% at all stations, with smaller dinoflagelate (cell size < 40 µm), such as *P. compressum*, being the dominant taxa.

References
1 - Vilicic, D., 1989. Phytoplankton population density and volume as indicators of eutrophication in the eastern part of the Adriatic Sea. *Hydrobiologia*, 174:117-132.
2 - Strickland, J. D. H. and Parsons, T. R., 1972. A practical handbook of seawater analysis. *Fish. Res. Board Can. Bull.*, 167: pp 310.
3 - Utermöhl, H. 1958. Zur Vervollkommnung der quantitativen Phytoplankton-Metodik. *Mitt. Int. Ver. Theor. Angew. Limnol.*, 9: 1-38.
4 - Margalef, R., 1965. Composición y distribución del fitoplancton. *Mem. Soc. Cienc. Natur. La Salle*, 25: 141-205.

ANNUAL DISTRIBUTION OF NUTRIENTS AND PHYTOPLANKTON IN THE MARINE LAKE MIR (MIDDLE ADRIATIC)

Marina Caric [1]*, Marijeta Calic [1] and Nenad Jasprica [1]
[1] Institute for marine and coastal research - marina.caric-gluncic@unidu.hr

Abstract
Phytoplankton and physical-chemical parameters were investigated in the marine Lake Mir special geomorphological phenomenon of the Telašcica Nature Park. Nutrient limitation appears to have been important in defining the lakes' seasonal phytoplankton composition. There was a predomination of small diatoms in spring and autumn, while dinoflagellate dominance began in May and continued during summer. The phytoplankton abundance and biomass were similar those recorded in highly productive coastal Adriatic areas and in the Mediterranean.
Keywords: Adriatic Sea, Nutrients, Phytoplankton

Introduction
There are several marine lakes along the Croatian coast and on the islands of the eastern part of the Adriatic Sea. Phytoplankton succession and community composition reflect the environmental conditions of the ecosystem, among which the availability of nutrients play a significant role. Changes in nutrient supply are often reflected in their ratios. Deviations from nutrient ratios sufficient for a healthy growth of phytoplankton [1,2], either in the nutrient availability or uptake indicate a potential for nutrient limited phytoplankton growth. The present work reports the key environmental variables, particularly nutrient ratios, as predictors of phytoplankton abundance and structure.

Results and Discussion
Marine Lake Mir is landlocked marine environment, situated on the southern edge of Dugi Otok Island. The only communication with the adjacent sea is through the system of subterranean caves and siphons. Physical-chemical parameters and phytoplankton were collected monthly from November 1999 to October 2000. Parameters were determined by standard oceanographic methods [3,4].

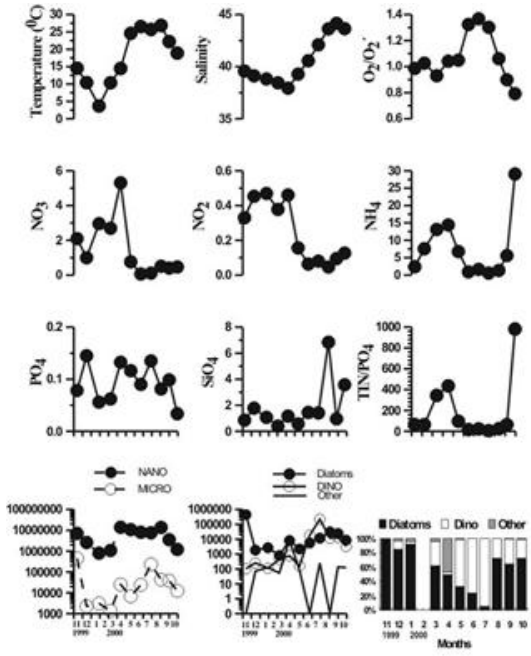


Fig. 1. Monthly distribution of physical-chemical parameters, MICRO, NANO, and relative contribution of different taxonomic groups to MICRO abundance in Lake Mir

During the investigation period (Fig.1) the temperature ranged from 3.65 ºC in January to 27.55 ºC in June, with annual temperature gradient of 24 ºC. Temperature rose from April to May and were more or less constant from June to August. In September, the water column began to cool. Throughout the year, the most of salinity values are greater than 39. in the summer period the salinity values are extremly high (>40) with the maximal value of 44.36 in September. In the water column doesn´t exist thermal or haline stratification throughout the year. Oxygen saturation (O_2/O_2') ranged from 0.74 to 1.43. Regarding nutrients, nitrate (NO_3) concentrations were low from June to October. Despite the depletion of nitrate, nitrogen limitation was found only in July, because of relatively high ammonium (NH_4) concentrations. Phosphate (PO_4) ranged from 0.02 to 0.19 µmol L^{-1} while silicate (SiO_4) ranged from 0.17 to 7.87 µmol L^{-1}. Microphytoplankton (MICRO) and nanophytoplankton (NANO) abundance ranged from 0.9 x 10^3 – 6.8 x 10^5 cells L^{-1} and 7.2 x 10^5 - 1.8 x 10^7 cells L^{-1}, respectively. Three peaks of MICRO were observed throughout the year (Fig.1). Domination of diatoms (mostly *Actinocyclus* sp.) was evident during the peaks in November 1999 and April 2000, when temperature and salinity were low and nitrate and ammonium were high. Dinoflagellates occurred in May and dominated the lakes' phytoplankton (65 - 95%) during the summer. Their dominance coincided with higher temperature, salinity, PO_4, and SiO_4, but lower NO_3. In July 2000, the MICRO peak was dominated by dinoflagellates (mostly *Scrippsiella trochoidea*). NANO was the dominant size fraction. The highest values of NANO were recorded in April and August 2000. Autumn, winter and spring provided an environment with low Si:N, while in summer Si:N, Si:P and N:P values indicated that no depletion of nutrients occurred (Fig.2).

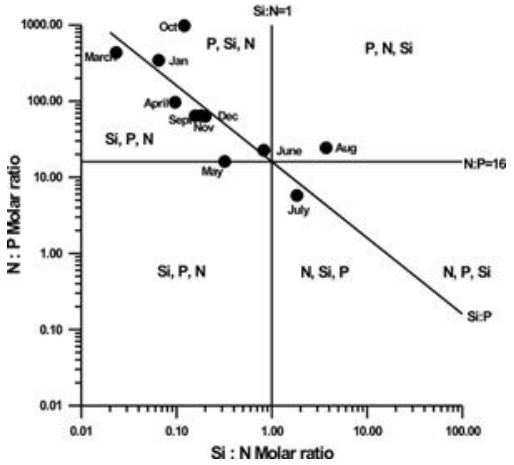


Fig. 2. Si:N:P molar ratios in Lake Mir. Molar quotients between *in situ* concentrations of potentially limiting nutrients are delimited by Si:N = 1, N:P = 16, and Si:P = 16 lines

References
1 - Brzezinski, M. A., 1985. The Si:C:N ratio of marine diatoms: interspecific variability and the effect of some environmental variables. *Journal of Phycology* 21, 347-357.
2 - Redfield, A. C., Ketchum, B. H., Richards, A., 1963. The influence of organisms on the composition of sea water. In: Hill, M.M. (Ed.) The sea, vol. 2. Interscience, New York, pp. 26-77.
3 - Strickland, J.D.H., Parsons, T.R., 1972. A practical handbook of seawater analysis. *Journal of the Fisheries Research Board of Canada* 167, 1-310.
4 - Utermöhl, H., 1958. Zur Vervollkommnung der quantitativen Phytoplankton-Metodik. *Mitteilungen Internationale Vereinigung für Limnologie* 9, 1-38.

FIRST DATA ON THE BENTHIC ASSEMBLAGES OF HARMFUL MICROALGAL SPECIES IN THE GULF OF TARANTO (NORTHERN IONIAN SEA)

Carmela Caroppo [1]* and Antonio Paride Bisci [1]

[1] Institute for Coastal Marine Environment, National Research Council - carmela.caroppo@iamc.cnr.it

Abstract

The benthic assemblages of harmful microalgal species have been detected for the first time in the Gulf of Taranto (Northern Ionian Sea).The most abundant species was *Ostreopsis* cfr. *ovata*, which was present in all the samples collected. The microalgal association was mostly composed of *Ostreopsis* cfr. *ovata*, *Coolia monotis*, *Amphidinium carterae* and *Coscinodiscus* sp., and showed features typical of both the Mediterranean and tropical assemblages.

Keywords: Algae, Toxic Blooms, Ionian Sea, Phytobenthos

Introduction

The biogeographical spreading of benthic dinoflagellates constitutes a major issue since the majority of them are capable of producing toxins [1], and raises questions about their origin and possible dispersal mechanisms [2, 3]. Among these dinoflagellates, the most known species *Ostreopsis* have today exceeded the biogeographical boundaries once considered for them (tropical and sub-tropical areas) and their presence in the Mediterranean Sea is actually well-documented [4]. In the tropical regions *Ostreopsis* genera are usually found in association with *Gambierdiscus*, *Prorocentrum* and *Amphidinium* species [5]. In the Mediterranean Sea, the assemblages of *Ostreopsis* with *Coolia monotis*, *Prorocentrum lima* and *Coscinodiscus* sp. [6, 7] have been detected. The aim of this study is to describe for the first time the benthic assemblages of harmful micro-algal species in the Gulf of Taranto (Northern Ionian Sea).

Material and mehods

In August 2008 samples of sediment were collected from three stations, located along the coastline of the Northern Ionian Sea (Mediterranean Sea) (1 = Mar Piccolo of Taranto; 2 = Mar Grande of Taranto; 3 = Lido Bruno) (Fig. 1). Samples of sediment (50–150 gr wet weight) were collected from depths between 0.5 and 1.5 m, placed in plastic bottles with filtered seawater and kept in the dark. In laboratory, sediment samples were vigorously shaken; the material was then passed through 250 and 100 mm mesh sieves to remove large particles, and was finally fixed with lugol's solution. The sediment was dried and then weighed. The fixed material was settled in 2–10 ml chambers for the appropriate time according to Utermöhl's sedimentation method [8]. Samples were examined and counted with an inverted microscope. The epiphytic abundance was expressed as cells gr^{-1} dry weight of sediment (dws).

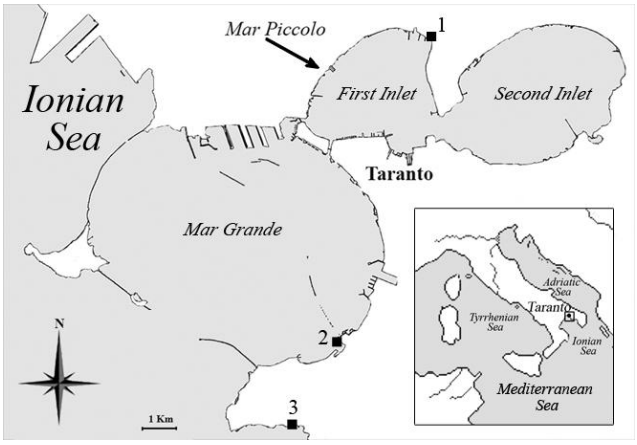


Fig. 1. Map of the Gulf of Taranto with sampling stations.

Results and discussion

The microalgal assemblages of sediments was dominated by dinoflagellates, the most of them potentially toxic (Table 1). *Ostreopsis cfr.* ovata, which was present in all the examined samples, reached the highest concentration at the stn. 3. The harmful dinoflagellates *Coolia monotis*, *Prorocentrum lima* and *Amphidinium carterae* were also abundant. Among diatoms, the genera *Coscinodiscus* and *Nitzschia* were important components of the assemblage. The benthic microalgal association detected in the Gulf of Taranto (*Ostreopsis* cfr. *ovata*, *Coolia monotis*, *Prorocentrum lima* and *Coscinodiscus* sp.) was similar to that found in other Mediterranean coastal areas, such as the Catalan [6], and the Northern Adriatic coasts [7]. Furthermore, the presence of *Amphidinium carterae*, typical of the tropical associations, and observed along the Southern Thyrrenian coast [9].has been confirmed also in the Nothern Ionian Sea. In conclusion, the establishment of tropical microalgal associations, besides the steady presence of "alien" species such as *Ostreopsis ovata*, seems to confirm the ongoing process of Mediterranean "tropicalization", even if the presented data must be considered only preliminary.

Tab. 1. List and abundances of the microalgal taxa detected in the sediments of the Gulf of Taranto.

	Toxic species	stn. 1 10^3 cells g^{-1} dws	stn. 2 10^3 cells g^{-1} dws	stn. 3 10^3 cells g^{-1} dws
diatoms				
Coscinodiscus sp.		54.9	73.2	54.9
Haslea wawrikae				
Navicula sp.		18.3		
Nitzschia sp.		36.6	54.9	27.45
Striatella sp.		3.66	1.83	3.66
other diatoms				
dinoflagellates				
Amphidinium carterae	*	18.3	36.6	25.62
Akashiwo sanguinea				
Coolia monotis	*	12.81	14.64	27.45
Gonyaulax spinifera				
Gymnodinium sp.		25.62	73.2	36.6
Ostreopsis cfr. *ovata*	*	109.8	91.5	237.9
Prorocentrum cfr. *lima*	*	7.32	12.81	9.15
Prorocentrum minimum	*			
Prorocentrum sp.1		3.66	3.66	9.15
others				
Dinobryon sp.				
phytoflagellates < 15 μm				
cyanobacteria		21.96	9.15	12.81

References

1 - Nakajima I., Oshima Y. and Yasumoto T., 1981. Toxicity of benthic dinoflagellates in Okinawa. *Bull. Jpn. Soc. Sci. Fish.*, 47: 1029-1033.

2 - Bomber J.W., Rubio M.G. and Norris D.R., 1989. Epiphytism of dinoflagellates associated with ciguatera: substrate specificity and nutrition. *Phycologia*, 28: 360-368.

3 - Tognetto L., Bellato S., Moro I. and Andreoli C., 1995. Occurrence of *Ostreopsis ovata* (Dinophyceae) in the Tyrrhenian Sea during summer 1994. *Bot. Mar.*, 38: 291-295.

4 - Aligizaki K. and Nikolaidis G., 2006. The presence of the potentially toxic genera *Ostreopsis* and *Coolia* (Dinophyceae) in the North Aegean Sea, Greece. *Harmful Algae*, 5: 717-730.

5 - Morton S.L., Norris D.R. and Bomber J.W., 1992. Effect of temperature, salinity and light intensity on the growth and seasonality of toxic dinoflagellates associated with ciguatera. *J. Exp. Mar. Biol. Ecol.*, 157: 79-90.

6 - Vila M., Garcés, E. and Masò M., 2001. Potentially toxic epiphytic dinoflagellate assemblages on macroalgae in the NW Mediterranean. *Aquat. Microbiol. Ecol*. 26, 51-60.

7 - Monti M., Minocci M., Beran A. and Iveša L.,2007. First record of *Ostreopsis* cfr. *ovata* on macroalgae in the Northern Adriatic Sea. *Mar Pollut. Bull.* , 54: 598-601.

8 - Utermöhl H., 1958. Zur Vervollkommnung der quantitativen Phytoplankton-Methodik. *Mitt. Int. Ver. Theor. Angew. Limnol.*,9: 1-38.

9 - Barone R., 2007. Behavioural trait of *Ostreopsis ovata* (Dinophyceae) in Mediterranean rock pools: the spider's strategy. *Harmful Algae News*, 33: 1-3.

ABUNDANCE AND DISTRIBUTION OF ACTIVELY RESPIRING BACTERIA IN A COASTAL-OFFSHORE TRANSECT OF THE TYRRHENIAN SEA(APRIL 2007)

G. Caruso [1]*, M. Azzaro [1], G. Maimone [1], R. Caruso [2] and G. Zappalà [1]
[1] National Research Council - Istituto per l' Ambiente Marino Costiero - gabriella.caruso@iamc.cnr.it
[2] A.O.U."G.Martino", Messina, Italy

Abstract
The abundance and distribution of actively respiring bacteria within the total prokaryotic community were estimated along the water column in a coastal-offshore transect crossing the Tyrrhenian Sea during spring 2007. Specific fluorochromes (SyBr Green and 3,5-cyano-dytolyl-tetrazolium chloride, CTC) were used to detect by flow cytometry the total prokaryotic community and the fraction of actively respiring bacteria, respectively. Bacterial numbers were compared to those determined by epifluorescence microscopy. Respiratory activity rates, leucine aminopeptidase and beta-glucosidase activity rates were also analysed, in order to relate the abundance of living cells to their functional role in the ecosystem functioning.
Keywords: Bacteria, Tyrrhenian Se, Analytical Methods

Introduction
The determination of cell viability is a critical issue in assessing the role of bacterial biomass in aquatic environments [1, 2]. Increased attention has recently been paid in determining the fraction of bacteria that are metabolically active and can be actively involved in biogeochemical cycles. Flow cytometry (FCM) with specific fluorochromes used allow us to discriminate bacterial cells according to their living attributes [2]. SyBr Green is a nucleic acid probe to stain the total prokaryotic community (TP), which fluoresces in the green range (maximum emission: 521 nm) of the light spectrum, when excited by a 488-nm wavelength light. The 5-cyano-2,3 ditolyl tetrazolium chloride (CTC) is a redox stain conventionally used as a marker of actively respiring cells, since in the presence of oxygen it is converted into formazan, which accumulates as red fluorescing granules within CTC+ cells [3]. The search aimed at evaluating, along a coastal-offshore transect crossing the Tyrrhenian Sea, the distribution of actively respiring bacteria within the prokaryotic community by FCM, in comparison with epifluorescence microscopy (EPI).

Materials and Methods
During April 2007, 31 seawater samples were collected by R/V "Universitatis", at depths from 5 to 3250 meters, in an area of the central Tyrrhenian Sea (Lat. 39°30'00''N-Long. 13°30'00''E to Lat. 40°36'30''N-Long. 14°08'30''E). The study was carried out within the VECTOR (VulnErability of the Italian coastal areas and marine ecosystems to Climate changes and Their rOle in the Mediterranean caRbon cycle) Project. Three stations (VTM, 2 and 5) were sampled; VTM was the most off-shore station (maximum depth: 3450 m), about 80 nautical miles SW of Naples, while station 5 was the most coastal one (maximum depth: 700 m). Before FCM and EPI analysis, a 5-ml water sample was pre-filtered on a 100 µm-mesh size net to prevent clogging of the flow cytometer. A 2 ml volume of the filtered sample was stained with SyBr Green II (Molecular Probes, final concentration: a 10^{-4} dilution of a 5 mg ml^{-1} stock solution) for 10 minutes in the dark at room temperature. A 1-ml aliquot of the SyBr Green-stained sample was added with a 5 mmol l^{-1} solution of CTC (final concentration; Polyscience), and analysed using an Apogee 40 flow cytometer (Apogee Flow Systems). Green fluorescence was collected in the FL1 channel(515-545 nm, specific for SyBr Green); red fluorescence was collected in the FL3 channel (650-690 nm, specific for CTC). The remaining 1 ml of the SyBr Green- and CTC-stained sample was stored at + 5°C until EPI analysis, performed within 2 hours of sampling.For EPI method, the water sample was filtered on a Nuclepore black (0.22 µm pore size) polycarbonate filter; the filter was observed with a Zeiss Axioplan 2 epifluorescence microscope, equipped with specific filter sets (blue light: BP 450-490, FT 510 and LP 520, for SyBr Green+ cells; green light: BP 510-560, FT 580 and LP 590, for CTC+ cells). On the same samples treated for FCM and EPI,temperature, salinity, oxygen, fluorescence, extracellular enzymatic activities (leucine aminopeptidase, LAP, β-glucosidase, β-Glu, alkaline phosphatase, AP) and microbial community respiration by the Electron Transport System (ETS assay)[4], were measured.

Results
Temperature ranged from 13.39 to 17.79°C; salinity from 37.56 to 38.73. TP counts obtained by FCM varied between 3.03 x 10^5 cells ml^{-1} (station VTM, 500 m) and 6.92 x 10^6 cells ml^{-1} (station 5, 100 m). CTC+ bacteria ranged from 1.94 x 10^4 to 1.19x10^6 cells ml^{-1}, recorded at station VTM (500 m) and at station 2 (1000 m); on average, they accounted for 8.8 (station VTM) and 16.28% (station 2) of TP. At station VTM, a decreasing trend for both TP and CTC+ cells was observed; an opposite distribution was found at stations 2 and 5. CTC+ cells were particularly abundant at station 2, between 500 and 1500 m, where values of 32.8-38% of TP were reached. TP counts obtained by EPI varied between 8.25 x 10^3 (station 5, 50 m) and 1.79 x 10^5 cells ml^{-1} (station VTM, 25 m). CTC+ bacteria ranged from 9.45 x 10^2 (station VTM, 500 m) to 2.39 x 10^4 cells ml^{-1} (station 2, 1000 m); on average, they represented 40.88% of TP. Spatial distribution of TP and CTC+ cells found by EPI followed the same vertical patterns as FCM. CTC+ cells predominated at station 2, accounting for over 70% of TP between 500 m and 1500 m. Significant relationships were always found between TP and CTC counts by FCM (Pearson r: 0.975, 0.845, 0.881, $P<0.01$, stations VTM, 2, and 5, respectively), since CTC+ cells belong to TP. Analysis of variance performed on samples grouped according to the main water masses (surface Tyrrhenian waters: 0-200 m, intermediate mixed waters: 200-1000 m, and deep waters: > 1000 m), showed that CTC+ cells were significantly higher in intermediate mixed layers than at surface ($F= 4.751$, $P<0.05$ for FCM). On average, FCM counts were two orders of magnitude higher than EPI counts, although no statistical differences were found between both the methods. At station 2, TP and CTC+ counts by FCM correlated positively with temperature (r= 0.818 and 0.836, $P<0.01$, respectively) and negatively with salinity (r= -0.72 and -0.637, $P<0.05$, respectively); CTC+ cells correlated negatively with oxygen (r= -0.851, $P<0.01$), suggesting its consumption during respiration. No relationships between CTC+ cells and ETS activity rates was generally detected, while CTC+ cells were related to LAP, β-Glu and AP (station VTM, r=0.781, 0.702, 0.798, $P<0.01$).

Discussion
FCM method is a suitable approach to study the physiological state (i.e. active respiration) of specific microbial populations which are active in the organic matter biogeochemistry. Actively respiring cells in the examined Tyrrhenian transect ranged in the same order of abundance as other marine environments [3, 5]; they prevailed in the intermediate layers, suggesting their distribution could be affected by water masses, like the Levantine Intermediate Water. The lack of relationships between CTC+ cell numbers and ETS activity rates confirms that cell abundance and activity may sometimes be uncoupled, because CTC method detects only the most highly active cells [5]. FCM and fluorochromes could represent a powerful tool also for monitoring bacterial cells for their living properties (enzyme activity, metabolism, respiration) in clinical samples, helping to better assess their potential pathogenic role.

Acknowledgements VECTOR Project was funded by the Italian Ministry of University and Research.

References
1 - Gasol J.M. and del Giorgio P.A., 2000. Using flow cytometry for counting natural planktonic bacteria and understanding the structure of planktonic bacterial communities. *Sci. Mar.*, 64: 197- 224.
2 - Porter J., Deere J., Pickup R., and Edwards C., 1996. Fluorescent probes and flow cytometry: new insights into environmental bacteriology. *Cytometry*, 23: 91-96.
3 - Sherr B.F., del Giorgio P. and Sherr E.B., 1999. Estimating abundance and single-cell characteristics of respiring bacteria via the redox dye CTC. *Aquat. Microb. Ecol.*, 18: 117-131.
4 - Caruso G., Monticelli L., Azzaro F., Azzaro M., Decembrini F., La Ferla R., Leonardi M., and Zaccone R., 2005. Dynamics of extracellular enzyme activities in a shallow Mediterranean ecosystem (Tindari ponds, Sicily). *Mar. Freshwat. Res.*, 56: 173-188.
5 - Karuza A., Del Negro P., Paoli A., Comisso S., Fonda Umani S., 2004. Highly active bacteria in the surface waters of the Gulf of Trieste (Northern Adriatic Sea). *Rapp. Comm. Int. Mer Médit.*, 37: 277.

THE BIO-STIMULATING EFFECTS OF INVASIVE *CAULERPA RACEMOSA* VAR. *CYLINDRACEA* EXTRACT ON *ORYZA SATIVA*

Levent Cavas [1]*, Mehmet Ulas Dural [1], Deniz Caparkaya [1] and Teoman Kesercioglu [2]
[1] Dokuz Eylul Uni. Faculty of Arts and Sciences, Department of Chemistry, Izmir-Turkey - lcavas@deu.edu.tr
[2] Faculty of Education Department of Science Education, Izmir, Turkey

Abstract
The effect of *Caulerpa racemosa* var. *cylindracea* extract on ascorbate peroxidase activity and lipid peroxidation levels of *Oryza sativa* seeds were determined.
Keywords: Aegean Sea, Biotechnologies, Enzymes

Introduction
Caulerpa racemosa var. *cylindracea* is one of the well-known invasive species in the Mediterranean Sea. This seaweed showed invasive character and observed in 13 Mediterranean countries after 1990 [1]. Seaweeds have various vitamins, amino acids, trace elements and hormone-based compounds in their tissues which are important for plant growth. Therefore, seaweeds extracts can be evaluated as a natural organic fertiliser [2]. Reactive oxygen species (ROS) are by-products of aerobic cell metabolism. ROS play vital roles in various aging and disease processes. Unscavenged ROS can easily attack and damage the important components of cell such as DNA, lipids and proteins [3]. Ascorbate peroxidase (APX) transforms the hydrogen peroxide to water via ascorbate. The disordered balance between oxidants and antioxidants is resulted with peroxidation of polyunsaturated fatty acids of the cell membrane. In these cases, antioxidant supplementation is needed for healthy crops [4]. The aim of this study was to investigate the effect of *Caulerpa racemosa* var. *cylindracea* extracts on APX activity and LPO levels in root and leaf of *Oryza sativa.*

Material and Methods
C.racemosa was collected from Dikili-Izmir in May 2009. The seaweeds were transported to the laboratory immediately, washed and then stored at -20 ^{0}C until used. Seaweed fertilizer was prepared according to Sivasankari et al.'s method [5]. *Oryza sativa* seeds were obtained from Ege Tarimsal Arastirma Enstitüsü (Aegean Agricultural Research Institute) Izmir, Turkey. After sterilization and soaked treatments, the seeds were watered with 15 ml 5%, 10%, 15%, 20% concentration of seaweed extracts every 24 h for 15 days in a growth chamber (Nuve ID 501). The conditions of growth chamber were 25 ^{0}C and 55% humidity level. After 15 days, germinated *Oryza sativa* were collected and 0.10 g of wet root and leaf were homogenized by adding 50 mM 2.0 ml phosphate buffer (pH 7.0). The activity of APX was measured according to the oxidation of ascorbate in the presence of hydrogen peroxide [6]. LPO level was estimated according to Zhu et. al. [7].

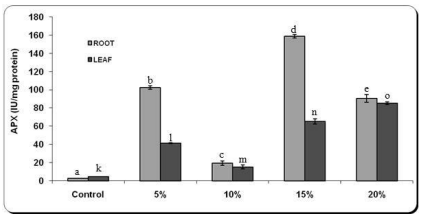


Fig. 1. The APX activities of *Oryza sativa* root and leaf. Different letters above the error bars indicate significant differences at p<0.05. The results are the means of three different experiments

Results and Discussion
According to Figure 1 maximum APX activity was found in root of *Oryza sativa* which was grown in the existence of 15% extract concentration (158.6 ± 1.9 IU/mg protein). As can seen from Figure 2 maximum LPO levels were observed in control groups root and leaf however the minimum LPO levels were found at 5% extract group. Abiotic factors are important sources of ROS. In these abnormal conditions, ROS are increased in plant metabolism and resulted in bad quality and low yield of agricultural product [8]. In the literature there are many reports on the effect of seaweeds extract to the plant growth. According to a recent paper, *Caulerpa chemnitzia* increases the biochemical parameters of *Vignia sinensis* [5]. This report was also well in line with the latter report. The present paper also revealed that *C.racemosa* extract supplemented seeds showed lower LPO levels compared to control groups. Therefore, it could be said that *C.racemosa* extract could be applied as antioxidant booster in organic agriculture.

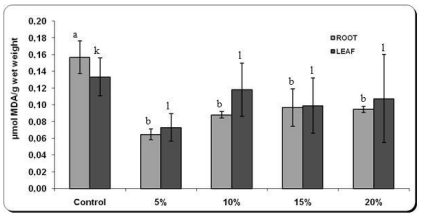


Fig. 2. The LPO levels of *Oryza sativa* root and leaf. Different letters above the error bars indicate significant differences at p<0.05. The results are the means of three different experiments

Acknowledgement The authors thanks to TUBITAK (The scientific and technological council of Turkey) for financial support (Grant no: 108O234).

References
1 - Klein J., Verlaque M., 2008. The *Caulerpa racemosa* invasion: A critical review *Mar. Pollut. Bull*., 56: 205-225.
2 - Challen S.B., Hemingway J.C., 1965. Growth of higher plants in response to feeding with seaweed extracts. Proc. 5th Ind. Seaweed Symp.
3 - Halliwell B., Gutteridge J.M.C. 2003. Free radicals in Biology and medicine. Oxford Univ. press, New York.
4 - Caparkaya D., Cavas L., Kesercioglu T., 2009. The bio-stimulating effects of invasive Caulerpa racemosa var. cylindracea extract on *Vigna sinesis* and *Phaseolus vulgaris* (Fabaceae). Hacattepe *J. Biol. & Chem*.37 (2):123-138.
5 - Sivasankari S., Venkatesalu V., Anantharaj M., Chandrasekaran M., 2006. Effects of seaweed extracts on the growth and biochemical constituents of *Vigna sinensis*. *Bioresour Technol*., 97: 1745-1751.
6 - Nakano Y., Asada K., 1981. Hydrogen peroxide is scavenged by ascorbate-specific peroxidase in spinach chloroplasts. *Plant Cell Physiol*.22: 867.
7 - Zhu Z., Wei G., Li J., Qian Q., Yu J., 2004. Silicon alleviates salt stress and increases antioxidant enzymes activity in leaves of salt-stressed cucumber (*Cucumis sativus L.*). *Plant Sci*., 167: 527-533.
8 - Burke J.J, 1990. High temperature stres and adaptation in Crops, In: R.G. Alscher, J.R. Cumming (Eds.). Stress Response in Plants : Adaptation and Acclimation Mechanism, Wiley, New York, pp. 295-309.

OCCURENCE OF LACTIC ACID BACTERIA (LAB) IN FARMED SEA BASS (DICENTRARCHUS LABRAX);AND SEA BREAM (SPARUS AURATA) SOUTHERN OF TUNISIA

O. Chahad [1], P. Calo-Mata [2], R. Mraouna [1], A. Boudabouss [3], J. Barros-Velàzquez [2] and M. El Bour [1]*
[1] Institut National des Sciences et Technologies de la Mer - elbour_ti@yahoo.fr
[2] 2School of Veterinary Sciences, University of Santiago. Lugo
[3] University of Tunis

Abstract
Lactic acid bacteria (LAB) collection was identified from enteric organs of healthy sea bass and sea bream cultured in tunisia. Thus we charecterized mainly Enterococci group with predominance of *E. faecium* (53%) and *E. faecalis* (21%). *E. sanguinicola, E. casseliflavus, E. mundtii, E. gallinarum, E. pseudoavium, lactococcus lactis, Aerococcus viridans* and *Carnobacterium sp*. were also identified by 16S rDNA sequencing and comparing RAPD-PCR profiles. Further, we obtained clear discrimination within species which were sensitive to vancomycin and resistants to others antibiotics tested.
Keywords: Aquaculture, Bacteria, Fishes

Introduction
LAB were described elsewhere as part of normal intestinal flora of fish and reported acting as probiotics since they can be harmless bacteriocin-producing bacteria and therefore may reduce the use of antibiotics in aquaculture [1]. The *Enterococcus* were LAB of primarily human and animal gastrointestinal flora which were introduced in farmed animals as biological control agents [2]. Here, we present investigation results of LAB isolated from healthy farmed sea bream and sea bass in Tunisia in order of to test their introduction as probiotics for the most valuable local cultured fish species.

Materials and methods
Sixty healthy fish specimens of sea bass and sea bream were collected from the greatest fish farm in southern zone of Tunisia (Monastir). Samples of skin patches and intestinal contents were sterily removed, homogenised and diluted in 0.9% saline solution and spread on MRS and M17 plates (Oxoid) before isolation and phenotypic characterization by mean of standard tests (colony and cell morphology, Gram stain, mobility, production of oxidase and catalase) and miniaturized API50CH biochemical tests (BioMérieux, France). Genetic characterization was performed using PCR-ribotyping of 16S rRNA sequences using universal primers p8FPL(5'-AGTTTGATCCTGGCTCAG-3') and p806R(5'-GGACTACCAGGGTATCTAAT-3'). Further genetic intra-specific characterization was performed by RAPD-PCR using M13 primer (5´-GAGGGTGGCGGTTCT-3´). In addition we test antibacterial sensitivity of all the strains by classical agar diffusion method [3].

Results and discussion
From eighty-four LAB strains isolated of fish samples : 32 strains were from skin and 52 from gut of both sea bream and sea bass. *E. faecium* was the most frequent (53%), followed by *E. faecalis* (21%). *E. sanguinicola* (8 strains), *E. casseliflavus* and *Aerococcus viridans (each* 3 strains) and *E. mundtii*, E. *gallinarum*, *E. pseudoavium*, *Lactococcus lactis* and *Carnobacterium sp*. (each one strain). The results obtained highlighted the first indigenous fish flora description of *E. faecalis, E. faecium* and other enterococci not previously considered [4]. Also, RAPD-PCR discrimination results were in agreement with phylogenetic analysis based on 16S rRNA sequences. From another view, *Enterococcus* isolates were sensitive to vancomycin and resistant to up to 10 ATB tested. Increasing use of antibiotics should be considered as principal cause of emergence for such resistance since supported by transfer of plasmids and transposable elements within marine ecosystem [6]. Present results should be considered in further to LAB investigation in fish both for probiotic assessments and antibacterial resistance treatment in aquaculture.

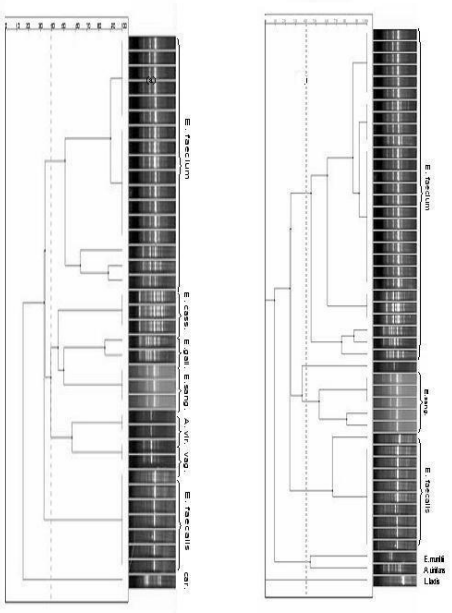


Fig. 1. RAPD patterns of the sea bream (a) and sea bass (b) isolates obtained by using the primer M13, and dendrogram obtained by UPGMA of correlation value of merged normalised RAPD patterns.

References
1 - Ringo E. et Gatesoupe F. J., 1998. Lactic acid bacteria in fish: a review. *Aquaculture*, 160, 177-203.
2 - Pilar C. M., Samuel A., Karola B., Trinidad M., Ananias P. and Jorge B. V., 2007. Current Applications and Future Trends of Lactic Acid Bacteria and their Bacteriocins for the Biopreservation of Aquatic Food Products. Food Bioprocess Technol.
3 - Chabbert Y.A., 1982. L'antibiogramme. In : Bactériologie médicale. Le Miror, M. véron, (eds) Flammarion. Medecine Science. Paris, 205-212.
4 - E. Ringo, H.R. Bendiksen, M.S. Wesmajervi, R.E. Olsen, P.A. Jansen and H. Mikkelsen., 2000. Lactic acid bacteria associated with the gigestive tract of Atlantic salmon (*Salmo salar* L.). *Journal of Applied Microbiology*, 89, 317-322.
5 - Andrighetto C. Knijiff E., Lombardi A., Torriani S., Vancanneyt M., Kersters K., S wings J. and Dellaglio F., 2001. Phenotypic and genetic diversity of enterococci isolated from italian cheeses. *J. Dairy Res*., 68, 303-316.
6 - Bhattacherjee J., Pathak S., Gaur A., 1988. Antibiotic resistance and metal tolerance of coliform bacteria isolated from Gomati River water at Lucknow city. *J. Gen. Appl. Microbiol.*, 34: 391-399.

MICROFOULING COMMUNITY IN BAY OF CARTHAGE (NORTHERN TUNISIA) : PRELIMINARY IDENTIFICATION AND BIOACTIVE PROPERTIES

Wafa Cherif [1], Leila Ktari [1]*, Ons Dali Yahya - Kefi [2] and Monia El Bour [1]
[1] INSTM: 28, Rue 2 mars 1934 Salammbo 2025 Tunisie - leila.ktari@instm.rnrt.tn
[2] INAT: 43, Avenue Charles Nicolle 1082 Cité Mahrajéne Tunisie

Abstract
Marine bio-fouling concerns any immersed structure. In order to specify fouling mechanism, we studied microbial communities and bioactive interactions for biofilms obtained from an experimental disposal.
Keywords: Fouling, Bacteria, Diatoms, Biodiversity

Introduction
In seawater, immersed structures rapidly accumulate colonising organisms that may range from microscopic bacteria to larger larvae or invertebrates. The first stage of this biofouling consists on a biofilm formed by unicellular organisms specially bacteria and microalgae [1]. Thus, we focused on these microfouling communities formed on an immersed experimental system to analyse biodiversity and potential biological activities.

Methods
Bacteria and microalgae were isolated from immersed steel and glass plates disposed in a shallow marine site (Bay of Carthage – northern coast of Tunisia) [2]. *Identification:* Bacteria strains were specified basically on cultural, morphological and biochemical identification while morphological identification of fouling microalgae was realised on the basis of microscopic observations. *Antagonism test :* Disc diffusion method [3] was used to detect the potential antagonistic effect of all isolates against 15 sensitive bacteria including fish and human pathogens.

Results and discussion
A group of thirty one bacterial strains were isolated with predominance of Gram negative (58%) mainly *Aeromonas hydrophila and Pseudomonas vesicularis* (Table1).

Tab. 1. Isolated microorganism from steel and glass plates.

Identified bacteria	Identified microalgae
Weeksella virosa; Shezanella putrefaciens; Chryseobacterium maningosepticum; Brevundimonas vesicularis; Staphylococcus Epidermidis; Aaeromonas hydrophyla; Staphylococcus xylosus; Pantoea spp.; Pseudomonas putida; Chryseobacterium indologenes ;	*Licmophora sp.; L. dalmatica; L. anglica; Nitzschia sp.; N. frustulum; N. palea; N. dissipata; N. longissima; N. angularis; Synedra sp.; S. barbatula; S. pulchella; Grammatophora sp.; G. oceanica; Peronia erinacea; Surirella sp.; Pleurosigma sp.; Fragilaria sp.; Navicula sp*

Besides, 19 different species of microalgae, all diatoms, were identified with dominance of: *Licmophora* and *Nitzschia.*
Antagonism test revealed interesting activities for one specie: *Chryseobacterium indologene*s with large spectrum of activity mainly against *Staphlococcus aureus* (Table 2).

Tab. 2. Antagonistic activity of fouling bacteria *Chryseobacterium indologenes* against pathogenic strains.

Test strains	Inhibition zone (mm)
Escherichia coli O126B16	12
Staphylococcus aureus ATCC 25923	35
Salmonella typhylium	10
E. coli ATCC25922	7
Enterococcus fecalis ATCC 29212	traces

Results obtained were in accordance with previous studies, particularly for the predominance of *Pseudomonas sp.* [4] in the bacterial community and *Licmophora sp.* for microalgae [5].
Further experimentations are in progress for molecular speciation of producers.

References
1 - Haras D., 2005. Biofilms et altérations des matériaux de l'analyse du phénomène aux stratégies de prévention. *Matériaux & Techniques* 93 : 27–41.
2 - Rubio C., 2002. Compréhension des mécanismes d'adhésion des biofilms en milieu marin en vue de la conception de nouveaux moyens de prévention. Thèse de l'université Paris VI. 216p.
3 - Lemos M.L., Toranzo A.E. and Barja J.L., 1985. Antibiotic activity of epiphytic bacteria isolated from intertidal seaweeds. *Microb Ecol*., 11: 149-163.
4 - Holmström C., Egan S., Franks A., McCloy S. Kjelleberg S. 2002. Antifouling activities expressed by marine surface associated *Pseudoalteromonas* species. *FEMS Microbioloy ecology* 41:47-58.
5 - Mitbavkar S., Anil A.Ch., 2008. Seasonal variations in the fouling diatom community structure from a monsoon influenced tropical estuary. *Biofouling*, 24 : 415 – 426.

A STUDY ON THE DEGRADATION ABILITY OF THE BACTERIA ISOLATED FROM THE SEA OF MARMARA IN OIL HYDROCARBONS, TURKEY

Pelin Saliha Ciftci [1]* and Gulsen Altug [1]
[1] Istanbul University - pciftci@istanbul.edu.tr

Abstract
In this study oil hydrocarbon degradation effect of 122 strains which were isolated from the coastal area of the Marmara Sea were investigated. The highest oil hydrocarbon degradation effect with respect to pH and oil layer thickness was observed in the single cultures of 112-*Enterobacter sakazakii*.
Keywords: Bacteria, Marmara Sea, Petroleum

Introduction
The fate of spilled oil in the marine environments depends on a number of factors such as evaporation, dissolution, microbial degradation and photo-oxidation. Understanding the degradation capability of bacteria and selecting of the most suitable oil degrading bacteria are important for bioremediation process [1] In this study the bacteria which were isolated potentially hydrocarbon polluted areas from the Marmara Sea were tested with respect to their oil degradation effect with an aim to detect the best candidate strains for furthers bioremediation studies.

Materials and Methods
The seawater samples were taken monthly from the four stations selected among ports (M1), oil stations (M2), marinas (M3) and fisherman shelters (M4) between July 2007 and June 2008. Isolates were identified [2] by API 20E and API 50 CHB (Biomereux, France). The single and mixed cultures of strains were screened using the Minimum Inhibition Concentration tests (MIC) with Batman crude oil (Figure 1). The isolates for which MIC values were determined were incubated in a shaking incubator at 150 rpm during 30 days and the ability of the isolates to degrade oil hydrocarbons was investigated by recording the oil layer thickness and the pH values in 72 hours intervals [3,4].

Results and Discussion
The differences of petroleum layer (cm) and pH values between the first and 30th days are shown in Figure 2. 112-E. sakazakii was recorded as the best candidate species between bacteria isolated from the studied area for bioremediation studies. The thickness of petroleum layer decreased from 1,2 cm to 0,2 cm in the single culture of E. sakazakii. In the single cultures of 111-E. corrodens and 109-P. aeruginosa, mixed culture I (P. aeruginosa+B. subtilis+E. coli), mixed culture II (P. aeruginosa+B. subtilis+V. fluvialis) the layer decreased from 1,2 cm to 0,4 cm. The petroleum layer thickness decreased from 1,2 cm to 1 cm in the single culture of 109-B. cepace. Oil degradation abilities of the mixed culture III (K. oxytoca+P. oryzihabitans+ P. mirabilis+E. sakazakii+E. corrodens) and the single culture of 108-K. oxytoca, 107-A. hydrophila,106-C. frenduii, 105-Providencia sp., have observed as low. The stocking of bacteria able to degrade oil hydrocarbons constitute basic data for our further studies intended to analytically determine which fractions of the oil was degraded by these bacteria.

Acknowledgement
This work was supported by Research Fund of the Istanbul University (Project number. T-32/15122006). We thank to Dr. Mine Cardak and Sevan Gurun for their assistances.

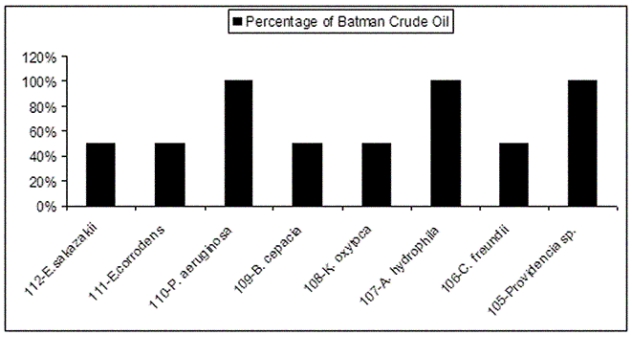


Fig. 1. The MIC values of the isolates

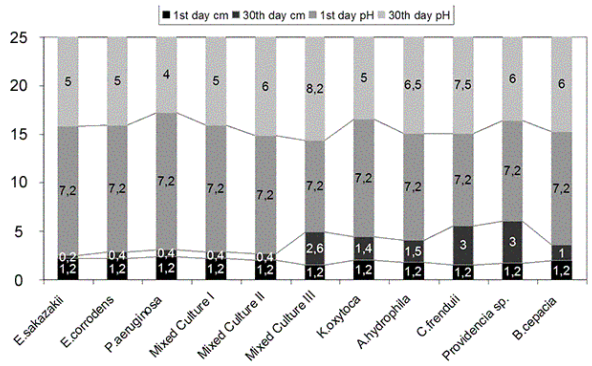


Fig. 2. The petroleum layer thickness (cm) and pH values of single and mixed cultures

References
1 - Reisfeld A., Rosenberg E. and Gutnick D., 1972. Microbial degradation of crude oil: Factors affecting the dispersion in sea water by mixed and pure cultures. *Appl. Microbiol*., vol. 24, pp. 363–368.
2 - Hitchins A.D., Feng P., WATKINS W.D., RIPLEY S.R., CHANDLER L.A.,1992. *Escherichia coli* and the Coliforms. Bacteriological Analytical Manual. 7th ed. American Public Health Association (APHA), Washington, DC, pp. 27-29.
3 - Geiselbrecht A.D., Herwig, R.P., Deming J.W., Staley J.T., 1996. Enumeration and phylogenetic analysis of polycyclic aromatic hydrocarbon-degrading marine bacteria from Pudget Sound sediments. Appl. *Environ. Microbiol*.62:3344–3349.
4 - Rahman K.S.M., Thahira-Rahman J., Lakshmanaperumalsamy P., Banat, I.M., 2002. Towards efficent crud oil degradation by a mixed bacterial consortium, *Bioresource Technology*, 85, 257-261.

MICROBIOLOGICAL QUALITY OF THE STRIPED VENUS (*CHAMELEA GALLINA)* AND WEDGE CLAM (*DONAX TRUNCULUS)* HARVESTED IN MARMASA SEA, TURKEY

Fatma Arik Colakoglu [1], Fikret Cakir [1], Hasan Basri Ormanci [1] and Çigdem Yigin [1]*

[1] Çanakkale Onsekiz Mart University, Fisheries Faculty, Dept. of Fishing and Processing Technology - cyigin@hotmail.com

Abstract

Microbiological quality of the economically important striped venus (*Chamelea gallina*) and wedge clam (*Donax trunculus*) were investigated in the Marmara Sea. In this purpose, total coliform, fecal coliform, *E. coli, Vibrio parahaemolyticus,* and *Salmonella* spp. of the clams were examined. In *C. gallina* total coliform, fecal coliform, and *E. coli* were below the limits of the Turkish Fisheries Regulations and EC Shellfish Hygiene Directive. Similar results were obtained for *D. trunculus*, except for one station in summer where *E. coli* were at the limit value. Although no *Salmonella* spp. were observed in both of the clams, *V. parahaemolyticus* was found in clams during the summer season. As a result, *E. coli* and *V. parahaemolyticus* in the clams, regular microbial monitoring of these species should be conducted in the Marmara Sea.

Keywords: Bivalves, Bacteria, Marmara Sea

Introduction

C. gallina and *D. trunculus* are the two most harvested and consumed bivalve species in all over the world that are more abundant in Marmara Sea and western Black Sea in Turkey. Bivalves are filter feeding and therefore tend to contain microorganisms in their body. Due to different factors that may contaminate the water column, pathogenic microorganisms may be harmful for human after consumption of these clams. For the assesment of the risk for human, *C. gallina* and *D. trunculus* were investigated for total coliform, fecal coliform, *E. coli, V. parahaemolyticus,* and *Salmonella* spp. between February 2008 and January 2009 in southern Marmara Sea.

Material and Method

Samplings were conducted between February 2008 and January 2009 seasonally from stations where natural stocks are found. *C. gallina* were sampled from five stations namely Sevketiye (SV), Kemer (KM), Karabiga (KB), Gelibolu (GB) and Bolayiralti (BA). *D. trunculus* were sampled from Karabiga (KB), Denizkent (DK) and Cardak (CR). The samples were collected along the littoral zone at 5 to 10 m depth using a mechanical dredge. Samples were stored at +4°C and transported to the laboratory. Microbiological analysis of total coliform (TC), fecal coliform (FC), *E. coli*, and *Salmonella* spp. (Sal) were conducted according to FDA (1998)(1) and the analysis of *V. parahaemolyticus* (Vib) were conducted according to FDA(2004)(2).

Result and Discussion

The results for *C. gallina* and *D. trunculus* are provided in Table 1 and Table 2. Because of the risks to human health, many countries developed regulations based on the microbiological analysis of the clams. According to the EC Shellfish Hygiene Directive (91/492/EEC) and Turkish Fisheries Regulation (Annex 7), tolerance levels for fecal coliform and *E. coli* in bivalves should be below 300 MPN/100g and 230 MPN/100g (3). According to FDA (US Food and Drug Administration) and EPA (US Environmental Protection Agency) regulations, the limit risk level for *E. coli* or fecal coliform is provided as 230 MPN/100g (4). *Salmonella* spp. and *V. parahaemolyticus* should not be any present in shellfish meat and fluid inside the shell. In this study *D. trunculus* had a *E. coli* value (230EMS/100g) which is exactly as the limit value during summer in Denizkent station and in the same station. Again, in summer, fecal coliform value (290EMS/100g) was close to the limit value. When considering the other seasons and bacteria groups, the bacteriological contents of clams were significantly ($p<0.05$) higher in Denizkent station. In all stations and seasons the indicator bacteria values in *C. gallina* were below the given limit values (3,4). Although the pathogenic bacteria *Salmonella* spp were not found in any of the samples, *V. parahaemolyticus* were found in *D. trunculus* speciesinthe Karabiga, Denizkent, and Çardak stations during summer. In *C.gallina* species *V. parahaemolyticus* was found in the Sevketiye and Kemer stations only once. As a result, in both clam species microbial values increased with the increasing water temperatures in summer. The reason of the increase during the summer season is due to the domestic and industrial sewages besides the increase of human activity on the shorelines. Although in most of the samples the increase of microbiological values are not reaching the critical limits for human consumptions, the *E.coli* and *V. parahaemolyticus* value observed at Denizkent for *D. trunculus* was reaching the critical limit and therefore regular microbiological monitoring of the species is suggested.

Tab. 1. Levels of microorganisms determined in *D. trunculus* at different seasons and stations

		TC	FC	*E.coli*	Vib.	Sal.
		Log N MPN/100g			Detected / 25 g	
Spring'08	KB	3,04±0,01	0,60±0,01	---	-	-
	DK	2,38±0,01	0,48±0,01	---	-	-
	CR	1,32±0,01	0,60±0,01	---	-	-
Summer'08	KB	3,04±0,01	2,32±0,01	2,17±0,01	+	-
	DK	3,04±0,01	2,46±0,01	2,36±0,01	+	-
	CR	3,04±0,01	0,85±0,01	---	+	-
Autumn'08	KB	2,18±0,01	0,60±0,01		-	-
	DK	2,18±0,01	1,18±0,01		-	-
	CR	1,97±0,01	---		-	-
Winter'09	KB	0,95±0,01	---	---	-	-
	DK	0,95±0,01	---	---	-	-
	CR	0,95±0,01	---	---	-	-

Tab. 2. Levels of microorganisms determined in *C. gallina* at different seasons and stations

		TC	FC	*E.coli*	Vib.	Sal.
		Log N MPN/100g			Detected / 25 g	
Spring'08	GB	2.18±0.01	1.18±0.01	0.94±0.10	-	-
	BA	2.38±0.01	---	---	-	-
	ŞV	2.38±0.01	0.95±0.01	0.54±0.06	-	-
	KM	1.97±0.01	0.60±0.01	---	-	-
	KB	1.36±0.01	---	---	-	-
Summer'08	GB	2.38±0.01	---	---	-	-
	BA	2.38±0.01	---	---	-	-
	ŞV	3.04±0.01	1.18±0.01	0.72±0.12	-	-
	KM	3.04±0.01	1.18±0.01	1.04±0.01	-	-
	KB	3.04±0.01	2.18±0.01	2.03±0.01	+	-
Autumn'08	GB	2.38±0.01	0.60±0.01	---	-	-
	BA	2.66±0.01	1.18±0.01	1.00±0.04	-	-
	ŞV	3.04±0.01	0.85±0.01	0.60±0.01	+	-
	KM	3.04±0.01	0.95±0.01	0.60±0.01	-	-
	KB	0.48±0.01	---	---	-	-
Winter'09	GB	1.97±0.01	1.36±0.01	1.15±0.01	-	-
	BA	1.36±0.01	0.95±0.01	0.30±0.30	-	-
	ŞV	2.89±0.19	1.83±0.14	0.94±0.10	-	-
	KM	2.78±0.54	1.52±0.17	0.78±0.18	-	-
	KB	1.36±0.01	0.95±0.01	---	-	-

>

References

1 - FDA., 1998. Bacterial Analytical Manual, 8th ed. Revision A. *AOAC International,* Washington, DC.

2 - FDA., 2004. *Food and Drug Administration Bacteriological Analytical Manual Chapter 9.*

3 - Anonymous., 1995. Fishery products law and regulation. Ankara, *Turkish Republic Ministry of Agriculture and Rural Affairs Press.* 85 pp.

4 - Anonymous., 2001. Commission regulation as regards heavy metals, directive 2001/22/EC, No: 466/2001. Setting maximum levels for certain contaminants in food stuffs.

LUMINOUS BACTERIA CHARACTERIZATION IN MEDITERRANEAN SEA WATERS

M. De Luca [1], B. Caldarone [1], G. Ruggeri [1], F. Smedile [1], M. De Domenico [1] and E. De Domenico [1]*
[1] Department of Animal Biology and Marine Ecology - University of Messina (Italy) - edd@unime.it

Abstract

To investigate luminous bacteria distribution in the Mediterranean Sea a multiyear study (2000-2009) was carried out in several areas from W to E (Gibraltar Straits - Crete Island), during several oceanographic cruises carried out in various seasons. By means classical identification pathways and molecular analyses (PCR, sequencing, etc) was carried out a taxonomic characterization from ca. 800 bioluminescent strains isolated in several sampling sites. *Photobacterium phosphoreum* was the more representative strain in the whole sampling area.

Keywords: Bacteria, Biogeography, Open Sea

Luminous bacteria (LB) are widely distributed and most abundant organisms light-emitting and are ubiquitous in the marine environment. LB interest several ecological niches: planktonic/free-living, parasitic, saprophytic, gut-symbiotic and light organ-symbiotic ([1],[2]). There are some studies describing the distribution and abundance of this group in the ocean ([3],[4]) but are very few data on LB distribution in the Mediterranean region. However are not yet perfectly known information regarding population dynamics, ecological function and role. According to molecular characterization and phylogeny, 11 species belonging to genera *Vibrio*, *Photobacterium* and *Shewanella* are reported to gather marine luminous bacteria ([5]) that can be divided in four groups: Shewanella group, Photobacterium group, Vibrio fischeri group and Vibrio harvey group ([6]). To understand better the distribution and ecology of luminous bacteria in the Mediterranean Sea, we examined over 3500 samples from about 210 sampling stations from the Straits of Gibraltar to the Island of Crete. Samples were filtered through a Millipore filter (0.47µm pore size), sewed on Petri dishes containing SWC agar medium and incubated in the dark at 20°C. Luminous colonies from plates of sampled depths (ca. 800 strains) were randomly selected, isolated and purified and 250, grown on replicates, were employed for taxonomic analysis. Total genomic DNA of each bioluminescent strain was extracted and PCR amplification of the 16S rRNA genes was performed using the primers 16F27 and 16R1492. Results were grouped into 7 areas: Gibraltar-Alboran, S-W Mediterranean, N-W Mediterranean, Sicily Straits, Tyrrhenian Sea, Ionian Sea, E Mediterranean. In the whole studied area *P. phosphoreum* (66.5%) was the most representative, whereas *V. fisheri* and *V. harveyi* presented values of 9,0% and *P. leiognathi* 8.5%. Other isolated strains belonged to *S. woodyi* (4.6%), *P. profundum* (0.5%) and unidentified strains (1.9%). Collected results (Fig.1) showed a significant geographical difference: the abundance of *P. phosphoreum* decreased moving from west to east, while *V. fisheri* and *V.harveyi* showed an opposite behavior. As far as vertical distribution is concerned, *P. phosphoreum* showed a wide distribution along the water column preferring the batypelagic layer (800m-bottom) while *V. fisheri*, did not found below 800m depth.

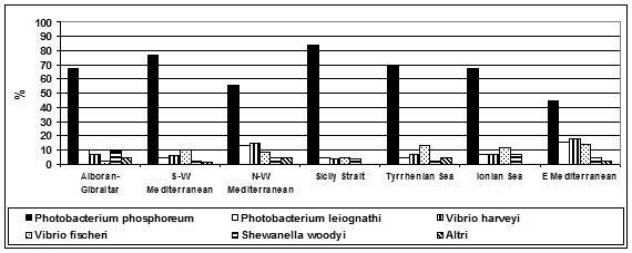


Fig. 1. Luminous bacteria strains distribution in Mediterranean Sea

References

1 - Lee K-H. and Ruby E.G., 1994. Effect of the squid host on the abundance and distribution of symbiotic Vibrio fischeri in nature. *Appl. Environ. Microbiol.*, 60:1565-1571.

2 - Nealson K.H. and Hastings J.W., 1992. The luminous bacteria. *In*: Balows A., Truper H.G., Dworkin M., Harder W. Schleifer K.-H. (Eds.), The Prokaryotes, second ed., Springer, NewYork, pp 625–639.

3 - Ruby, E. G., Greenberg E. P. and Hastings J. W., 1980. Planktonic marine luminous bacteria: species distribution in the water column. *Appl. Environ. Microbiol.*, 39(2): 302-306.

4 - Orndorff S. A. and Colwell R., 1980. Distribution and Identification of Luminous Bacteria from the Sargasso Sea. *Appl. Environ. Microbiol.*, 39(5): 983-987.

5 - Hsiu-Hui C., Hsiao-Hui C., Wen-Dar J. and Wung-Yang S., 2007. Isolation and characterization of marine luminous bacteria from shallow costal waters of Taiwan. *J. Microbiol. Immunol. Infect.*, 40: 14-23.

6 - Makemson J.C., Fulayfil N.R., Landry W., Ert L.M.V., Wimpee C.F., Widder E.A. and Case J.F., 1997. Shewanella woodyi sp. nov., an exclusively respiratory luminous bacterium isolated from the Alboran Sea. *Int. J. Syst. Bacteriol.*, 47: 1034–1039.

DISSOLUTION OF BIOGENIC SILICA IN ADRIATIC WATER MASSES

P. Del Negro [1]*, A. Bergamasco [2], M. Celussi [1], C. Comici [1], E. Crevatin [1], C. Falconi [1] and M. Giani [1]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS BIO - pdelnegro@ogs.trieste.it
[2] CNR ISMAR

Abstract

Dissolution of diatom biogenic silica (BSiO2) and its control by prokaryotic activity were investigated in different Adriatic water masses.

Keywords: Adriatic Sea, Biokinetics

In the Adriatic sea, diatoms are the most important primary producers and represent the basis of pelagic and benthic coastal food chains. Orto-silicic acid [Si(OH)4] is an essential requirement in the formation of diatom frustules and its availability depends on both external inputs and internal recycling. Although the recycling of biogenic silica (BSiO2) at the sediment-water interface has already been quantified in different environments (1), very little is known about the processes of the silica cycle that occur along the water column, particularly below the euphotic zone. The silica cycle in Adriatic coastal ecosystem is now receiving much attention, because the increased P limitation conditions is changing the chemical composition of coastal waters. This may favour drastic modifications to phytoplankton community structure. Current biogeochemical models assume biogenic silica dissolution to be controlled by temperature, zooplankton grazing and diatom aggregation (2) but the role of prokaryotes has not been well established. Prokaryotes utilize the organic matter derived from primary production by varied strategies, including attack on dead and living diatoms by using hydrolytic enzyme, and could hasten silica dissolution by degrading the organic matrix which protects diatom frustule from dissolution. Here we report the results of experiments carried out on three Adriatic waters in which we measured BSiO2 dissolution kinetics and prokaryotic enzymatic hydrolysis. During an oceanographic cruise carried out during December 2007 on bord on Dallaporta CNR vessel, we sampled three different waters (surface - SW, Adriatic Deep Waters - AdDW, Modified Levantine Intermediate Waters - MLIW) in the southern Adriatic basin. 50 L microcosms were incubated under controlled temperature and BSiO2, POC, Si(OH)4 concentrations were analysed at different time intervals. Additionally, the diatom and prokaryotic abundances were detected. Since of the organic matrix is a key biochemical mechanism regulating diatom-silica recycling, we measured protease activity and calculated the enzyme kinetics in order to verify if different environmental conditions induce a variation in the conformation and thus in the efficiency of the enzymes produced. The results showed a fast increase in Si(OH)4 inside the deep and surface waters associated to an increase in enzymatic activity. Prokaryotes mediate potentially rapid but highly variable silicon regeneration rates enhancing the role of microbial loop on diatoms production and their biogeochemical fate in the Adriatic ecosystem.

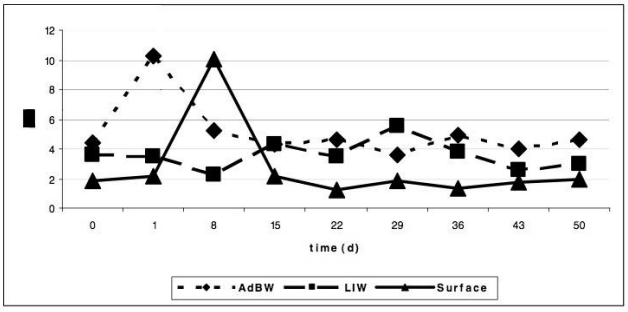


Fig. 1. Time evolution of dissolved silica(µM)

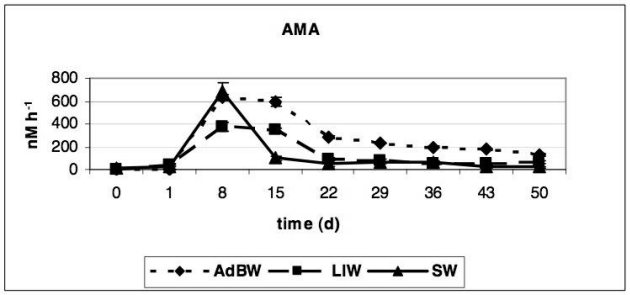


Fig. 2. Time evolution of aminopeptidase activity (AMA) (nM h^{-1})

References

1 - Chauvaud L., Jean F., Ragueneau O. and Thouzean G., 2000. Long term variation of the Bay of Brest ecosystem : benthic-pelagic coupling revisited. *Mar. Ecol. Prog. Ser*., 200: 35- 48.

2 - Bidle K.D. and Azam F., 1999. Accelerated dissolution of diatom silica by marine bacterial assemblages. *Nature*, 397: 508-512.

ISOLATION OF HOT SPRING CYANOBACTERIA FROM IZMIR AND COMPARISON OF PYCOBILIPROTEINS

Zeliha Demirel [1]* and Atakan Sukatar [1]
[1] Ege University, Faculty of Science, Department of Biology - zelihademirel@gmail.com

Abstract
Cyanobacteria (blue-green algae) strains were isolated from hot springs area of Seferihisar, Zeytindali, Sifne-Izmir, Turkey. Filamentous cyanobacteria are rich source of phycobiliproteins. Phycobiliproteins located in the thyllakoid membranes of the cells, are functional light harvesting protein-pigment complexes, while the membrane-bound chlorophyll protein complexes were hardly impaired as demonstrated by SDS polyacrylamide gel electrophoresis. In this study, the filamentous cyanobacteria are isolation and cultivated crude extracts are obtained from phycobiliprotein after harvesting.
Keywords: Cyanophyta, Cyanobacteria, Pigments

Introduction
Blue-green algae (cyanobacteria) are prokaryotic microorganisms and have many beneficial features; they are very nutritive and have therapeutic effects such as immuno enhancing [1], [2] antioxidant, antiviral [3], and antiinflammatory effects [4]. In this study, the phycobiliprotein of filamentous cyanobacteria, isolated from different hot spring area in Izmir-Turkey, was isolated and cultivated. In a previous study carried out with protein content of the extracts. After cultivation of cyanobacteria biomass, crude extracts were obtained from all species.

Materials and Methods
Isolation was done by plating on to Blue-Green Algae Medium (BG-11) containing 1.5 % agar. Individual cells were picked up and inoculated into the liquid medium. Protein contents of the extracts were determined by Bradford methods [5]. Sodium dodecylsulfate-polyacrylamide gel electrophoresis (SDS-PAGE) was carried out according to Okadjima et al. (1993) using a 12.5% polyacrylamide gel and Brilliant Blue R was used for visualization the proteins.

Result and Discussion
The number of species of microalgae is estimated at 22.000 to 26.000, however only a little part of these organisms have been studied in detail with regard to their biochemistry and ecophysiology [7]. Cyanobacteria(blue-green algae) play an important role for being the only source of the blue pigment phycocyanin, and since Spirulina is a very rich source of valuable chemicals, particularly C-PC, commercialized for its use for medical purpose[8]. This is the first study on a purified from hot spring isolate of cyanobacteria. Isolation and cultivation of the cyanobacteria from these samples, three different media were tested. It was observed that isolated colonies from each medium grew best in BG-11 medium. Consequently, four different filamentous cyanobacteriae strains were isolated on BG-11 medium. The crude extracts (1-5) were confirmed by SDS-PAGE (Fig 1).

References
1 - Hayashi, O. and Katoh, T., 1994. Enhancement of antibody production in mice by dietary Spirulina platensis. *J Nutr Sci Vitaminol.* 40: 431-441.
2 - Qureshi, M. and Ali, R., 1996. Spirulina platensis exposure enhances macrophage phagocytic function in cats. Immunopharmacol. *Immunotoxicol.* 18: 457-463.
3 - Gustafson, K. R., Cardellina, J. H., Fuller, R. W., Werslow, O. S., Kiser, R. F., Snader, K. M. and Patterson, G. M. L., 1989. AIDS: antiviral sulfolipids from cyanobacteria (blue-green algae). *J. Natl. Cancer Inst.* 81: 1254-1258.
4 - Liu, Y., Xu, L., Ni, C., Li., L. and Zhang, C., 2000. Inhibitory effect of phycocyanin from Spirulina platensis on the growth of human leukemia K562 cells. *J. Appl. Phycology* 12, 125-130.
5 - Bradford, M.M., 1976. A Rapid and Sensitive Method for the Quantitation of Microgram Quantities of Protein Utilizing the Principle of Protein-Dye Binding. *Analytical Biochemistry* 72: 248-254.
6 - Okadjima, T., Tanabe, T. and Yasuda, T., 1993. Nonurea sodium dodecyl sulfate-polyacrylamide gel electrophoresis with high-molarity buffers for the separation of protein and peptides. *Anal. Biochem.* 211, 293-300.
7 - Sasson, A., 1997. Microalgal Biotechonolgies: Recent Development and Prospects for Developing Countries. Thailand
8 - Reddy, M.C., Subhashini, J., Mahipal, S.V., Bhat, V.B., Reddy, P. S., Kiranmai, G., Madyastha, K. M. and Reddanna, P., 2003. C-Phycocyanin, a selective cyclooxygenase-2 inhibitor, induces apoptosis in lipopolysaccharide-stimulated RAW 264.7 macrophages. *Biochemical and Biophysical Research Communications*, 304, 385-392.

PHYTOPLANKTON ASSEMBLAGES AND DENSITY IN THE MONTENEGRIN COASTAL SEA

Dragana Drakulovic [1]* and Nenad Vuksanovic [1]
[1] Institute of marine biology - ddragana@t-com.me

Abstract

The Montenegrin coast is influenced by extensive use of the littoral zone and increasing development of tourism. All these changes cause increased eutrophication. We studied microphytoplankton assemblages from April to September 2009 in Boka Kotorska Bay and the Montenegro coast. The highest values of microphytoplankton density and some species indicators of eutrophication were found in the inner part of Boka Kotorska Bay.

Keywords: Coastal Waters, Plankton, Adriatic Sea, Eutrophication

Introduction

Boka Kotorska Bay is a part of the Montenegrin coast, located in the southeastern part of the Adriatic Sea. Due to its structure, values of some parameters indicators of eutrophication level are high enough to classify the region region as eutrophic.

Materials for investigation were collected from April to September 2009 in monthly intervals at 15 stations in the inner part (Kotor Bay and Risan Bay), middle part (Tivat Bay), outer part (Herceg Novi Bay) of Boka Kotorska Bay and outside the Bay, in the open sea (Fig.1). Samples were taken using 5l Niskin bottles on three depths (surface, middle and bottom). Microplankton abundance was determined using a Leica inverted microscope [1]. Chlorophyll *a* concentration was determined by measurement of absorbance with a Perkin-Elmer spectrophotometer and calculation according to Jeffrey et al. [2].

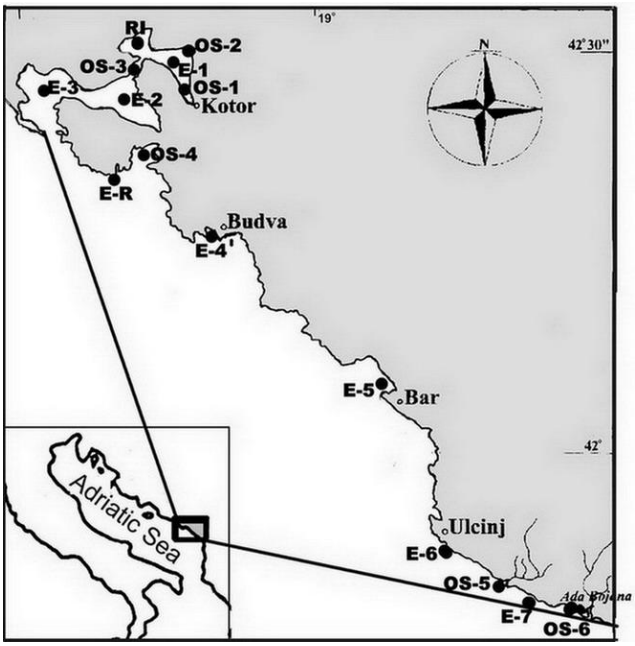


Fig. 1. Investigated area

Results

Oxygen saturation was positively correlated with microplankton abundances. Maximum values (from 115.7% to 125%) were found in July. The largest mean value of microplankton abundance was found in July (8.40 x 10^5cells L^{-1}). Also in July we noticed two more peaks (3.86 x 10^5 and 3.08 x 10^5cells L^{-1}). The fourth peak occurred in August (3.05 x 10^5 cells L^{-1}). All peaks were found in the summer period in the inner part of Boka Kotorska Bay. Outside the Bay values were lower, with maximum abundance of 7.84 x 10^4 cells L^{-1} in the mouth of Bojana river. On the surface layer maximum microplankton abundances were on the order of 10^6, as it is present in the other eutrophic region [3].

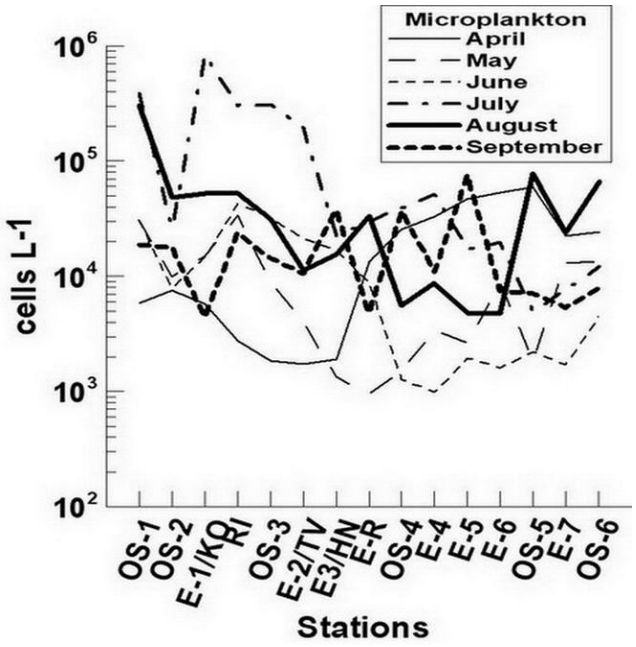


Fig. 2. Means values of microplankton abundance

Diatoms dominated the phytoplankton community throughout the study period period with maximum on surface (2.51 x 10^6 cells L^{-1}) in July. Abundance of dinoflagellates increased in summer, but diatoms were the most abundant. Some species appeared throughout the study. Some of them are: *Thallasionema nitzschioides, Pseudonitzschia spp., Prorocentrum micans, Gymnodinium spp.* Concentration of chlorophyll *a* in August was 2.675 mg/m^3, when the fourth peak of microplankton abundance occurred. In July concentrations were lower (from 0.80 to 1.69 mg/m^3). These changes can be explained by different photosynthetic activities, in different cell size fractions, and different phytoplankton composition [4].

Conclusion

Maximum values of phytoplankton abundance and diversity in the summer period were caused by untreated sewage waters. The change of environmental conditions due to human activities in the Montenegrin coast are rapid, and permanent seawater monitoring is necessary.

References

1 - Utermohl C.,1958. Zur Vervollkommnung der quantitativen Phytoplankton Methodik. *Mitt. Int. Ver. theor. angew. Limnol.,9:1-38.*

2 - Jeffrey S. W., Mantoura R.F.C., Wright S.W., 1997. Phytoplankton pigments in Oceanography. UNESCO, Paris.

3 - Regner D., Vuksanovic N., Stjepcevic,B., Dutina M., Joksimovic D., 2002. Sea-water quality and level of eutrophication in the Montenegrin coastal sea. *Stud. Mar*., 23,1: 71-78.

4 - Krivokapic S., Stankovic Ž., Vuksanovic N., 2008. Seasonal variations of phytoplankton biomass and environmental conditions in the inner Boka Kotorska Bay (eastern Adriatic sea). *Acta Bot. Croat*. 68, 1: 45-55.

LE PHYTOPLANCTON TOXIQUE AU NIVEAU DU GOLFE DE GABES DURANT QUATRE CAMPAGNES OCEANOGRAPHIQUES (2005-2007)

Z. Drira [1]*, A. Hamza [1], M. Bel Hassen [1], A. Bouaïn [1], L. Aleya [2] and H. Ayadi [1]

[1] Université de Sfax, Faculté des sciences de Sfax. Département des sciences de la vie. Unité de recherche UR/05ES05. Biodiversité et Ecosystèmes Aquatiques. Route de Soukra Km 3,5. BP 1171. CP 3000.Sfax, Tunisie. - zaherbmc@yahoo.fr

[2] Université de Franche-Comté, Laboratoire de Chrono-Environnement, UMR CNRS 6249, 1, Place Leclerc, 25030 Besançon cedex, France.

Abstract

Cette étude a révélé la présence de 18 espèces toxiques appartenant aux groupes des dinoflagellés et des cyanobactéries dans le golfe de Gabes. Les cyanobactéries toxiques sont composées d'une seule espèce "opportuniste" *Pseudoanabaena galeata* qui représente 11% du phytoplancton total et 74% du phytoplancton toxique. 17 espèces de dinoflagellés toxiques forment à elles seules 5% du phytoplancton total et 36% du phytoplancton toxique. L'espèce *Karenia selliformis* représente 18% du phytoplancton toxique. La dynamique de ces différentes espèces toxiques est fortement dépendante des conditions hydrologiques dans le golfe de Gabès.

Keywords: Gulf Of Gabes, Phytoplankton, Hydrography, Toxic Blooms

Introduction

Le développement des blooms phytoplanctoniques contribuant à la formation des eaux colorées est en expansion tant par leur nombre que par leur fréquence et intensité [1]. Les eaux colorées sont nocives à la santé humaine, notamment lorsqu'il s'agit d'un développement d'espèces phytoplanctoniques toxiques [2], [3]. Les efflorescences d'algues toxiques ont été décrites en Méditerranée [4] notamment dans le golfe de Gabès depuis 1935 [5]. Dans cet écosystème, une prolifération excessive d'une cyanobactérie *Oscillatoria* sp. récemment appelée *Trichodesmium erytreum* a été observée au mois de juillet 1988 [6].

Matériel & Méthodes

Dans le cadre d'un projet intitulé "POEMM (LR02INSTM04" quatre campagnes d'échantillonnage à bord du navire de recherche océanographique et halieutique 'Hannibal R/V' ont été réalisées à différentes périodes de l'année (juillet 2005, mai-juin 2006, septembre 2006 et mars 2007) [7]. Durant chaque campagne, 30 stations ont été prospectées afin de réaliser une étude qualitative et quantitative des communautés phytoplanctoniques toxiques. L'étude qualitative et quantitative du phytoplancton a été réalisé en utilisant un microscope à phase inverse selon la méthode d'Utermöhl [8].

Résultats & discussion

L'étude qualitative et quantitative du phytoplancton total a montré la présence de 172 différentes espèces appartenant à 7 groupes [7]. Au cours de cette étude, nous avons identifié 18 espèces toxiques, appartenant essentiellement aux groupes des dinoflagellés et des cyanobactéries et qui représentent respectivement 5 et 11% du phytoplancton total. Les cyanobactéries toxiques, représentés par l'espèce *Pseudoanabaena galeata*, constituent 74% de la flore cyanobactérienne totale (Figure 1). Les dinoflagellés constituent 36% de l'abondance totale du phytoplancton toxique. Ils sont composés de 17 espèces toxiques dont la plus importante est *Karenia selliformis* qui représente 18% de la totalité des espèces toxiques (Figure 1). La thermocline (mai-juin 2006) est caractérisée par une nette dominance de *Pseudoanabaena galeata* représentant 88% des espèces toxiques (Figure 1). Cette espèce reste aussi dominante (71%) avec l'établissement d'une stratification thermique (juillet 2005) ; mais, suite à l'augmentation de la température, une stratification thermique s'est installée en septembre 2006, et nous avons observé une nette dominance de *Karenia selliformis* (74% des espèces toxiques). En revanche, *Pseudoanabaena galeata* montre une faible abondance ne dépassant pas les 0,5% des espèces toxiques. Le même résultat est observé dans le golfe de Gabès en octobre 2000, où 10 espèces toxiques sont présentes dont *Karenia selliformis* est la plus abondante [9]. Néanmoins, d'après Turki et al. [9], une faible densité de l'espèce toxique *Karenia* a été observée dans le nord-est du golfe de la Nouvelle Zélande. Lorsque la colonne d'eau est bien mélangée (mars 2007) on note une abondance excessive de *Pseudoanabaena galeata* (88% des espèces toxiques). Le même phénomène s'est manifesté dans différentes zones du golfe de Gabès durant les années 90 [5].

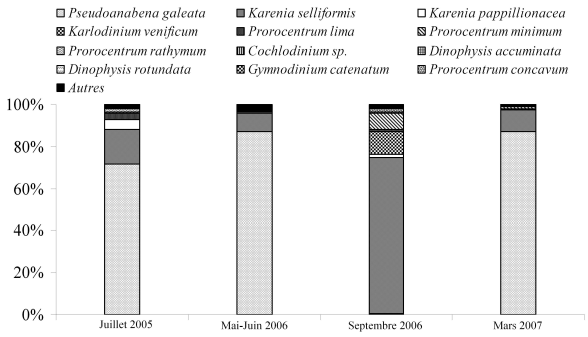


Fig. 1. Abondance relative des différentes espèces phytoplanctoniques toxiques au niveau du golfe de Gabès durant quatre campagnes d'échantillonnage (2005-2007)

References

1 - Hallegraeff, G.M., 1993. A review of harmful algal blooms and their apparent global increase. *Phycologia* 32(2): 79-99.

2 - Baden, D.G. & Trainer, V.L., 1993. Mode of action of toxins of seafood poisoning. In Falconer, I.A. (ed.), Algal Toxins in Seafood and Drinking Water. Academic Press, London, San Diego, New York, Boston, Sydney, Tokyo, Toronto: 49-74.

3 - Geohab., 2003. Global Ecology and Oceanography of Harmful Algal Blooms, Implementation Plan. In : Gentien, P., Pitcher, G., Cembella, A. & Gilbert, P., (ed.). SCOR and IOC. Batlimore and Paris. 44 pp.

4 - Vila, M., Capm, J., Garcés, E., Maso, M. & Delgado, M., 2001. High resolution spatio-temporal detection of potentially harmful dinoflagellates in confined waters of the NW Mediterranean. *J. Plankton Res.* 23(5): 497-514.

5 - Hamza, A., Dammak, H., Medhioub, A., Medhioub, N.,Sahraoui, H., Mahfoudhi, M. & Kharrat, R., 2007. Variability of levels toxicity for dinoflagellate in Gabes coasts and sojourn time in shellfish in field and in detoxification experiment. *IOC / HANA –First Workshop on Harmful Algal Blooms in North Africa. Casablanca 18-20 October 2007.*

6 - Fremy, A.P. & Feldmann, J., 1935. Matériaux pour la flore algologique marine de la Tunisie: Contribution à l'étude biologique et systématique de la muffa. *Notes Station océanographique* 29: 5-24.

7 - Drira Z., Bel Hassen M., Hamza A., Rebai A., Bouaïn A., Ayadi H., Aleya L., 2009. Spatial and temporal variations of microphytoplankton composition related to hydrographic conditions in the Gulf of Gabes. *J. Mar. Biol. Assoc. U.K.* 1-11. doi: 10.1017/S002531540900023X.

8 - Utermöhl H., 1958. Zur Vervollkommung der quantitativen Phytoplankton Methodik. *Verh. Int. Ver. Theor. Angew. Limnol.*, 9, 1-38.

9 - Turki, S., Harzallah, A. & Sammari, C., 2006. Occurrence of harmful dinoflagellates in two different Tunisian ecosystems: the lake of Bizerte and the gulf of Gabes. *Cah. Biol. Mar*. 47: 1-7.

DETECTION OF ANTIMICROBIA ACTIVITY IN SPONGE SPECIES FROM TUNISIAN COAST (CENTRAL MEDITERRANEAN)

Monia El Bour [1]*
[1] National Institute Of Sea Sciences and Technologies - monia.elbour@instm.rnrt.tn

Abstract
To investigate antibacterial activities in sponges, we test 53 samples collected from different areas in Tunisian coasts. Three species (hymeniacidon sp, Fsciospongia sp and Aplysina aerophoba) shown antibacterial activities against several Gram neagtive pathogen bacteria. Sponge species represent source of several antibacterial compounds.
Keywords: Coastal Waters, Bacteria, Biotechnologies

Introduction
Sponges were described as source of different bioactive compounds (antiviral, antitumoral, antibacterial..etc) with great benefit for pharmaceutical industry. Previous studies highlighted antimicrobial activity of sponges and pointed them as most significant invertebrate producers [1]. Here we report results of antimicrobial activities revealed from Tunisian sponge species.

Materials and methods
Sponges (53 samples) were collected in shallow coastal water (2 and 6m) from different Tunisian coastal areas. Their identification was based on morphology of spiculs and microscopic observations of their skeletal structures. Extraction of their bio products was realized using 2 solvents: acetone and methanol. All extracts obtained were tested by diffusion method against different bacterial species: *Vibrio alginolyticus*, *Pseudomonas aeruginosa*, *Aeromonas hydrophila*, *Escherichia coli* and *Salmonella Typhimurium*.

Results and discussion
Sponges collected (53 samples) belonged to order of Dictyoceratida and were subdivided in 4 families: *Irciniidae*, *Thorectidaes*, *Halichondriidae* and *Spongidae*. Three isolated species shown large inhibition of bacteria: *Hymeniacidon sp*, *Fasciospongia sp* and *Aplysina aerophoba* with strong activities on all pathogens tested.
Inhibition obtained was variable depending on bacteria species, category of solvent and sampling areas. Thus, most significant activity was reported for *Fasciospongia sp* on *Salmonella typhimurium* using acetone solvent extract. Such results were in agreement with [2]. Depending on sampling area, *Fasciospongia sp* from Kerkennah and *Hymeniacidon sp* from Salammbô have most significant activities compared respectively to those of Bahiret El Biban and Korbous. Since local sponge species seemed to harbour interesting bioactive components, we continue further investigations on the specific bioactive compounds and their eventual relation with epibionts.

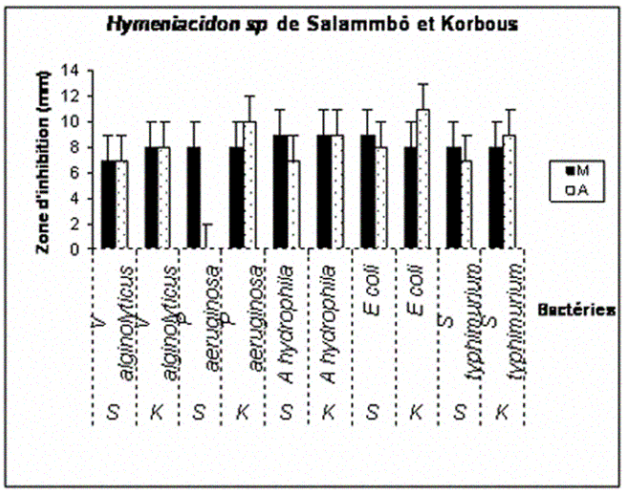


Fig. 1. Identification of antibacterial activity of *Hymeniacidon sp* from Salammbô and Korbous against different bacterial species. **M**: Methanol extracts, **A**: Acetone extracts

References

1 - Mohapatra B., Bapuji R. and Sree A., 2003. Production of industrial enzymes (Amylase, carboxy-methyl cellulase and protease) by bacteria isolated from marine sedentary organisms. *Acta of Biotechnology*., 23-1: 75-84.
2 - Lee Y.K., Lee J-H. and Lee H.K., 2001. Microbial symbiosis in marine sponges. *Journal of Microbiology*, 39-4: 254-264.

UTILISATION DE LA PCR MULTIPLEX POUR LA CARACTERISATION DE *SALMONELLA ENTERICA* SER. TYPHIMURIUM CHEZ LA PALOURDE *RUDITAPES DECUSSATUS*

S. El Mejri [1], M. El Bour [1], I. Boukef [1]*, N. Al Gallas [2], O. Bahri [3], R. Mraouna [1] and A. Boudabbous [4]

[1] laboratoire de Microbiologie et de Pathologies des animaux aquatiques-INSTM-Salambôo-Tunisie - imen.boukef@lycos.com

[2] Laboratoire de contrôle des eaux et des denrées alimentaires-Institut Pasteur -Tunisie

[3] Laboratoire de virologie clinique-Institut Pasteur de Tunis-Tunisie

[4] Laboratoire de Microbiologie et des molécules bioactives-Faculté des Sciences de Tunis-Tunisie

Abstract

Salmonella enterica ser.Typhimurium a été identifiée par utilisation de la technique PCR Multiplex chez la palourde *Ruditapes decussatus* et comparée aux souches de référence C52 et LT2. Leur virulence a été mise en évidence par tests de cytotoxicité. D'après les résultats obtenus, un même sérotype présente deux profils différents de pathogénicité et le titre de cytotoxicité chez les Salmonelles Typhimurium isolées du milieu naturel demeure relativement élevé.

Keywords: Bacteria, Bivalves, Gulf Of Gabes

Introduction

Un nombre considérable de gènes (de l'ordre de quelques centaines) doivent être mobilisés par *Salmonella* Typhimurium pour échapper aux mécanismes de défense de l'hôte. Les facteurs de virulence spécifiques sont codés par des îlots de pathogénicité (un à plusieurs gènes associés à la virulence), en plus des îlots génomiques [1], [2]. Cette étude décrit l'identification de *S.* Typhimurium par des gènes de virulence, grâce à la technique de PCR multiplex.

Matériel et méthode

Extraction de l'ADN chromosomique: L'extraction de l'ADN génomique est effectuée selon le procédé de « boiling method » à partir de cultures bactériennes de *Salmonella enterica* serovar Typhimurium dont six sont isolées à partir de la palourde *Ruditapes decussatus* et deux sont des souches référence respectivement *S.* Typhimurium C52 et *S.* Typhimurium LT2 [3]. L'amplification génique par PCR multiplex : trois paires d'amorces ont été choisies, PhoP, Hin et Hli, donnant respectivement des bandes de 299 pb, 236 pb et 173 pb. Test de cytotoxicité : le surnageant des cultures bactériennes qui contient les toxines est mis en contact avec des Cellules Vero, cette suspension est incubée à 37°C dans une atmosphère à 5% de CO_2 pendant 48 à 72 h [3].

Résultats et Discussion

Les résultats de la caractérisation moléculaire de *Salmonella* Typhimurium sont résumés dans le tableau 1. L'amorce PhoP amplifie une région de 299 pb, cette amorce non spécifique des Salmonelles, caractérise également la présence de coliformes. Les amorces Hin et Hli, spécifiques des gènes impliqués dans le contrôle du système de variation de phase chez les Salmonelles, amplifient respectivement une région de 236 pb et 173 pb. Une seule de ces bandes suffit pour détecter une *Salmonella* Sp. (Figure 1). Ces résultats sont concordants avec les travaux de Ben Salem [4] et l'étude de Way *et al.* [5].

Tab. 1. Caractérisation de *Salmonella* Typhimurium isolées à partir de la palourde *Ruditapes decussatus*

Souche	H3	H4	H5	H6	H9	H10	C52	H10
Titre de cytotoxicité (CFU/ml	10^{-5}	$10^{-5.5}$	10^{-6}	10^{-7}	10^{-5}	$10^{-6.5}$	$10^{-7.5}$	10^{-7}
Profil de Pathogénicité	3 bandes (299-236-173pb)	2 bandes (299-236pb)	3 bandes (299-236-173pb)	2 bandes (299-236pb)	3 bandes (299-236-173pb)	3 bandes (299-236-173pb)	3 bandes (299-236-173pb)	3 bandes (299-236-173pb)

Nota : H3, H4, H5, H6, H9, H10 : *Salmonella Typhimurium* isolées à partir de la palourde ; C52, LT2 : *Salmonella Typhimurium*

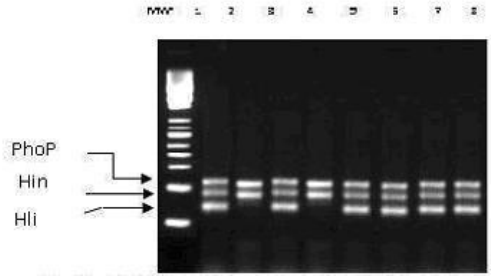


Fig. 1. Profil électrophorétique des îlots de pathogénicité de *Salmonella* Typhimurium. 1-6: *S.* Typhimurium isolées de la palourde; 7: *S.* Typhimurium C52; 8: *S.* Typhimurium LT2

References

1 - Doublet B., Boyd D., Mulvay M., Cloeckaert A., 2005. The *Salmonella* genomic island is an integrative mobilizable element. *Mol. Microbiol*. 55 (6): 1911-1924.

2 - Dobrindt U., Hochhut B., Hentschel U., Hacker J., 2004. Genomic islands in pathogenic and environmental microorganisms. *Nat. Rev. Microbiol*. 2: 414-424.

3 - Al Gallas N., Olfa Bahri, Ridha Ben Aissa., 2006. Prevalence of Shiga Toxin-Producing *Escherichia coli* in a Diarrheagenic Tunisian Population, and the Report of Isolating STEC O157:H7 in Tunis. *Cur. Microbiol*. 53: 483-490.

4 - Ben Salem I. 2008. Detection des Salmonelles dans les aliments par multiplex PCR. Mastére. Fac. Phar. Monastir. 110p.

5 - Way J.S., Josephson K.L., Pillai S.D., Abbaszadegan M., Gerba C.P., Pepper I.L., 1993. Specific detection of *salmonella* spp. by multiplex polymerase Chain Reaction. *App. Environ.Microbiol*. 59: 1473-1479.

PHYTOPLANKTONIC COMMUNITIES IN EUTROPHIC COASTAL LAGOONS OF THE NORTHERN ADRIATIC SEA, ITALY.

Chiara Facca [1]*, Adriano Sfriso [1] and Sonia Ceoldo [1]
[1] Department of Environmental Sciences, University Ca' Foscari, Venice, 30123, Italy - facca@unive.it

Abstract
Water column samples were collected in some coastal lagoons in the north-western Adriatic Sea (Italy) in order to evaluate the phytoplankton taxonomic composition and cell abundance. These areas are strongly affected by anthropic exploitation and impacted by industrial, agricultural and urban discharges. Except for the records of the Venice Lagoon, where monthly samplings were carried out in two sites from March 2008 to February 2009, in the other basins the samples were collected twice in several stations. Flagellates often represented the bulk of the community, whereas dinoflagellates were almost negligible. Diatoms were occasionally dominant in spring or summer. Cell abundance varied between 0.39 and 30.5 x 10^6 cells/L.
Keywords: Phytoplankton, Nutrients, Lagoons

Introduction
The Italian coastline of the North Adriatic Sea displays a complex system of lagoons (Fig. 1), which receives the river discharges from a wide, densely populated and highly industrialized drainage basin. This determines high nutrients and pollutant inputs. Even though the most exploited basin is the lagoon of Venice, also the other wetlands present important anthropic activities; in particular extensive and intensive aquaculture installations are renowned in the area of the Po river delta lagoons. In order to describe and compare the environmental conditions in that basins water samples were collected to measure phytoplankton communities and nutrient concentrations.

Materials and Methods
Water samples were collected in 19 stations in July 2007 and in May 2008 in the Grado-Marano lagoon, which is characterized by high nitrate and mercury inputs. In the lagoon of Venice the campaigns were carried out in two sites from March 2008 to February 2009. The sampling stations were located between the Venice historical centre, where a sewage treatment plant does not exist, and the Porto Marghera industrial area. In the Veneto area of the Po river delta, water column was sampled in 17 sites in October 2008 and in July 2009. Phytoplankton was determined according the Utermöhl's method [1] and nutrients according the Strickland and Parson's procedure [2].

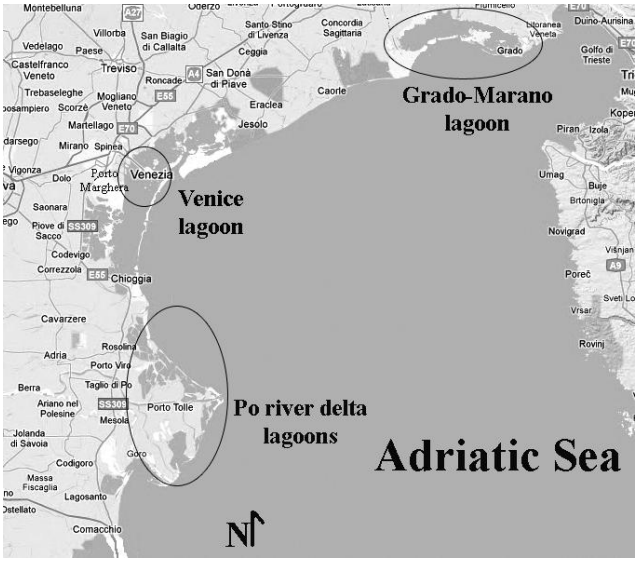


Fig. 1. Map of the study area. Circles marked the sampling basins.

Results and discussion
Phytoplankton cell abundance varied more or less in the same range in the lagoons of Grado-Marano and Venice with minimum of 0.23-0.39 x 10^6 cells/L and peaks of 17.5-22.1 x 10^6 cells/L. In the Po river delta lagoons, maxima values reached up to 30.5 x 10^6 cells/L. Even though the samples were collected in different periods and with different frequency, the results allowed to highlight some particular conditions. In the case of the Grado-Marano lagoon, the highest values was observed in July 2007 close to the river discharge, where nitrate concentration was >50 µM and it was due to *Cylindrotheca closterium* and *Nitzschia frustulum* bloom. In a couple of basins in the Po river delta lagoon system, the phosphorus concentrations were comprised between 5 and 25 µM during the October 2008 sampling campaign, but the phytoplankton community did not exceed 10^6 cells/L, probably because of the low light availability. In the lagoon of Venice the community composition and cell abundance in the two sampling sites appeared to have some interesting differences, mainly due to the different depth and water circulation. The annual mean cell abundance was, in fact, higher in the site near the canal (4.43 x 10^6 cells/L) than in the shallow bottom area (2.80 x 10^6 cells/L). Moreover, both nanoflagellates and *Skeletonema marinoi* blooms were more marked near the canals than in the shallow bottoms, where *Thalassiosira* sp. and Cryptophyceae prevailed. In the Po river delta lagoons, the highest abundance was observed in July 2009, due to a equal contribute of flagellates and diatoms. Except for few cases, flagellates, in particular unidentified nanoflagellates, were always the dominant group. Dinoflagellates, on the contrary, never exceeded 2.4% of cell abundance, being negligible in most of the records. Diatoms displayed high variability ranging between 1.8 and 81.8%. It was observed that diatoms happened to be significantly abundant in summer in the lagoons of Grado-Marano and Venice, and in autumn in the Po river delta lagoons. Even though the species occurrence was quite similar in all the studied sites, small colonial centric diatoms such as *Chaetoceros* spp. prevailed in the Po river delta lagoons whereas in the lagoons of Grado-Marano and Venice benthic diatoms seemed to be more frequent.

References
1 - Utermöhl H., 1958. Zur Vervollkomnung der quantitativen Phytoplankton-Methodik. *Mitt. Int. Verein. Limnol*., 9: 1-38.
2 - Strickland J.D.H. and Parson T.R., 1972. A Practical Handbook of Seawater Analyses. *Fish. Res. Bd. Canada*, 167: 1-310.

MICROBIAL DESULFURIZATION OF EGYPTIAN CRUDE OIL BY A YEAST STRAIN ISOLATED FROM OIL POLLUTED SEA WATER

Laila Abdel Moneim Farahat [1]* and Nour Shafik El-Gendy [1]
[1] Egyptian Petroleum Research Institute, Nasr city-Cairo, Egypt - lailafarahat@yahoo.com

Abstract
Sulfides and thiophenic compounds specially Benzothiophene and Di-benzothiophene (BTs and DBTs) are the main sulfur types present in crude oil and its distillates (diesel) where their removals are very difficult by hydrodesulfuri-zation (HDS). As an alternative method is microbial desulfurization by *Candida parapsilosis* Nsh45, a locally isolated microorganism, from Egyptian hydrocarbon sea water. It was found that it is very efficient to remove up to 82% of 12.400 ppm sulfur content in diesel oil and ≈75% from Belayim mix crude oil, respectively keeping the calorific value unchanged.
Keywords: Biotechnologies, Petroleum, Pollution, Red Sea

Introduction
In Egyptian crude oil, sulfur content ranges between (0.04- 4.19 wt.%) including DBTs and BTs and another thiophene compounds. The presence of sulfur has been correlated with the corrosion of pipelines, pumping and refining equipments. Hydrodesulfurization (HDS) is the current method used for sulfur removal, which is not only energy and capital intensive but also suffers from limitations in the removal of typical sulfur bearing aromatic compounds such as (DBT) and its derivatives. Microbial removal of organic sulfur from crude oil offers an attractive route because of the mild operating conditions afforded by the biocatalyst [1] offering significant cost and safety advantages. The first microorganism capable of S removal Rhodococcus rhodochrous (IGTS 8) that selectively cleaves sulfur from DBT through the 4S' pathway [2] In this work we study the BDS activity of a new isolated yeast strain *Candida parapsilosis* N.Sh 45 [3] on DBT. It is then applied to desulfurize diesel and crude oil comparing it with the standard strain *Rhodococcus erytrhopilis* (IGTS8).

Experimental work: The experiment was done using sterilized oil and basal salts medium (BSM) to study the ability of *Candida parapsilosis* NSh 45 to grow and desulfurize egyptian diesel of initial sulfur content (12,400 ppm) and Belayim mix crude oil (BX 2.76% sulfur). The desulfurization was carried here with the ratio of oil/BSM 1/3 (v/v) at pH 7 and inoculation size 10%. The cultures and the control oil were incubated at 30ºc and checking speed 200 rpm. Diesel oil was subjected to GC-FID analysis. Sulfur removal was determined using x ray sulfur meter (ASTM, D4294). Calorific value and dynamic viscosity were also measured to determine the effective microbial treatment.

Results and discussions
Identifications of the metabolites using GC-MS suggested that NSh 45 metabolized DBT trough the 4S pathway. This result is in agreement to that obtained by Baldy *et al* [4].

Biodesulfurization of Diesel oil: The effect of microbial treatment on diesel oil was studied after 7 days of incubation. The GC –FPD chromatogram of biodesulfurised diesel oil revealed extensive depletion of sulfur compounds (mainly BTs and DBTs) across the entire boiling range of the oil, with BDS potential of about 82% as shown in the figure.

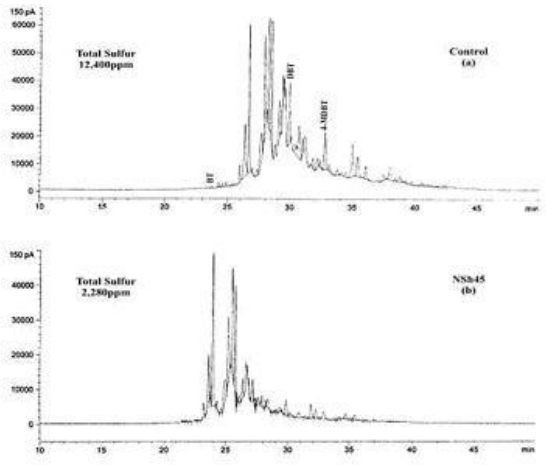


Fig. 1. GC-FPD chromatogram showing OSC in diesel oil

Biodesulfurization of crude oil: The effect of microbial desulfurization treatment of belayim mix 2.76% was studied after 7 days of incubation. Gravimetric determination of asphaltene content showed a decrease in its weight percentage associated with the decrease in sulphur content of the crude oil. GPC data of the average molecular weight in the following table support the above results where there was a general decrease in the average Mwt of asphaltene fraction and decrease in the dynamic viscosity about 69.62% [5].

Tab. 1. Effect of crude oil BDS on; asphaltene and maltene ratios, asphaltene Mwt and viscosity

Sample / Parameter	Control	NSh45	IGTS8
S-content (%wt.)	2.76%	0.70%	0.99%
%BDS		75%	64.0 %
% Maltene	92.00%	94.64%	93.97%
% Asphaltene	8.00%	5.36%	6.03%
Asphaltene Mwt.	14,384	10,371	10,978%
Viscosity (cp)	655	199	236

Conclusion
It was found that *Candida parapsilosis* is very efficient to remove up to 82% of 12,400 ppm sulfur content in diesel oil and approximately 75% from Belayim mix crude oil with initial sulfur content of 2.76% compared to the standard strain *Rhodococcus erythopilis* IGTS8 wich removed up to 46% and 64% from the diesel and crude oil respectively.

References
1 - Chen H., Zhang W., Chen J., Cai Y., Li W., 2008, Desulfurization of various organic sulfur compounds and the mixture of DBT + 4,6-DMDBT by *Mycobacterium* sp. ZD-19.Bioresour.Technol.99:3630-3634.
2 - Kayser K.J., Bielaga-Jones B.A., Jackowski k., Oudson O., Kilbane., 1993, Utilization of organosulphur compounds by axenic and mixed cultures of *Rhodococcus rhodochrous* IGTS8.J.Gen.Microbio139: 3123-3129.
3 - Nour Sh. El-Gendy., 2004, Biodesulfurization potentials of crude oil by bacteria isolated from hydrocarbon polluted environments in Egypt, Ph.D,thesis.
4 - Baldi F., Pepi M & Fava ., 2003, Growth of Rhodosporidium toruloides strain DBVPG 6662 on dibenzothiophene crystals and orimulsion. Appl. Environ. Microbiol.69 (8):4689-4696
5 - Mishra S., Sarma P.M. & Lal B., 2004, Crude oil degradation efficiency of a recombinant lux tagged Acinetobacter baumannii strain and its survival in crude oil contaminated soil microcosm, FEMS Microbiol. Lett. 235: 323-331.

PHOTOSYNTHETIC PIGMENTS IN MUCILAGE AGGREGATES AND SURROUNDING WATER IN THE NORTHERN ADRIATIC

Vesna Flander-Putrle [1]* and Alenka Malej [1]
[1] Marine Biology Station, National Institute of Biology - flander@mbss.org

Abstract
Massive amounts of mucilage aggregates have been observed in different marine environments worldwide but the northern Adriatic seems to be most severily affected. Our observations indicated that the phenomenon passed through a characteristic "life cycle" and variable phytoplankton composition assessed by pigment biomarkers (HPLC). The number of phytoplankton groups decreased as the aggregates aged and diatoms increased in relative biomass (up to 92.7 %). Phytoplankton biomass in seawater was similar in years with and without mucilage. Significantly higher contributions to the total biomass of 19 '-hexanoyloxyfucoxanthin-containing phytoplankton (prymnesiophytes) were found in the upper 10 m preceding the mucilage phenomenon, followed by prevalence of diatoms in summer.
Keywords: Adriatic Sea, Mucus Aggregates, Phytoplankton, Pigments

Introduction
Several types of aggregates are observed in the northern Adriatic. Occasionally, masses of mucilage remained suspended in the water column of the northern Adriatic for up to several months during the summer stratified season (from May to September). Calm weather favours aggregation, whereas intense mixing during strong north-easterly winds can cause a decay of the event during its early phase. Eventually, mucilage accumulates on the shores and bottom and generally disappears by autumnal vertical mixing although recently it was observed also in other seasons. The main goal of our research was to elucidate and quantify the composition of the phytoplankton assemblages in the different types of macroaggregates.

Methods
Samples of mucilage aggregates were collected in the eastern part of the Gulf of Trieste during summers 1997 and 2000, on the surface and in the water column. Seawater samples for a time course of pigments in ambient water were taken monthly (from May to September 1997 and 2000) at 6 different depths. Water samples were filtered through GF/F filters, mucilage samples were concentrated, and both immediately frozen until analysed. Observations of the evolution of mucilage phenomenon were carried out weekly by SCUBA divers, who recorded the phenomenon. Using HPLC (High Performance Liquid Chromatography) pigment analysis we determined the phytoplankton community structure.

Results
Several kinds of mucilaginous aggregates were observed during this study. Different forms of mucilage may co-exist in the water column. Phytoplankton biomass in the mucilage samples was very high (from 7.9 µg/g to 390.8 µg/g of chlorophyll a per unit of dry mass of mucilage). Generally, chlorophyll a per dry mass was lower in loose networks of mucilage in the layer above the thermocline compared to its concentration in the mucilage clouds and compact yellowish-brown mucilage found predominantly in, and below the thermocline layer. As the aggregates aged diatoms increased in relative biomass (up to 92.7 %). Cluster analysis of mucilage data indicated three, rather distinct mucilaginous groupings: (1) mucilage at the sea surface, (2) mucilage from the water column around the thermocline layer, and (3) "aged" mucilage samples collected deeper and later in the season. The surface group appears to be more similar to the deepest group than to the intermediate group located between the surface and deep groups. PCA performed with the contribution of seven phytoplankton groups in different mucilage samples from 2000, was used to determine the course of mucilage development. An ordination plot produced showed the progression of fresh mucilaginous aggregates (with prymnesiophytes and silicoflagellates), to intermediate mucilaginous stages (heterogeneous phytoplankton community), and to aged mucilaginous aggregates (with prevalence of diatoms). Comparisons of the succession of phytoplankton groups in the water column showed differences between mucilaginous and non-mucilaginous years. The former were characterised by a higher contribution of prymnesiophytes in spring, and the prevalence of diatoms in summer. The single pigment index, F_p, used to capture the trophic status of an ecological province [1], showed a clear difference between mucilaginous and non-mucilaginous years. In April-May (1997 and 2000), before the appearance of mucilage, F_p ratios were lower compared to the non-mucilaginous years. In contrast, when mucilage occurred in June-August, F_p ratios were higher than during non-mucilaginous years. A similar pattern was observed in year 2005, when the F_p index was very low (0.20±0.07) during April-May due to the high contribution of 19'-hexanoyloxyfucoxanthin-containing phytoplankton - prymnesiophytes. Later on (in June) we observed the beginning of mucilage formation, but due to the weather conditions that followed, with summer storms and strong winds, the mucilage phenomenon did not develop.

Discussion and conclusions
The mucilage phenomenon shows an evolution [2]. Weekly or more frequent observations during the summers of 1997, 2000, 2002 and 2004 indicated that the phenomenon passed through a characteristic "life cycle". Phytoplankton composition in loose mucilaginous aggregates above the thermocline at different periods was very similar, indicating that fresh mucilage may form in the upper water column over a period of several weeks to months. The loose, web-like mucilage that developed earlier in the sequence of mucilage formation seemed, therefore, to be a favourable microenvironment for the development of autotrophs, resulting in higher chlorophyll a per dry mass in the more compacted mucilage clouds found deeper in the water column. Overall, the fucoxanthin concentrations revealed that diatoms were the main contributor to phytoplankton biomass in the mucilaginous aggregates. In contrast, phytoplankton biomass in seawater during a mucilage event did not significantly differ from years when mucilage did not occur. These findings indicate that the development of macroaggregates did not significantly affect the phytoplankton biomass in surrounding seawater. Our results suggest that the role of prymnesiophytes and other small flagellated forms in the initiating of mucilage development are crucial, and indicate the F_p index during spring as possible predictor of mucilage appearance.

References
1 - Claustre H., 1994. The trophic status of various oceanic provinces as revealed by phytoplankton pigment signatures. *Limnol. Oceanogr.*, 39(5): 1206-1210.
2 - Flander-Putrle V. and Malej A., 2008. The evolution and phytoplankton composition of mucilaginous aggregates in the northern Adriatic Sea. *Harmful Algae*, 7: 752-761.

SEM MICROPHOTOGRAPHS OF BIOFOULING ORGANISMS ON FLOATING AND BENTHIC PLASTIC DEBRIS

J. Fortuño [1]*, M. Masó [1], R. Sáez [1], S. De Juan [1] and M. Demestre [1]
[1] Institut de Ciències del Mar (CSIC). - jmanuel@icm.csic.es

Abstract
Results from the first electron microscopic observations of both floating a bentic marine plastics debris are presented. Plastics were collected near the marine protected area of the Cap de Creus(Catalan Coast). Floating plastics microphotographs showed fungi and bacteria as the first settlers and a high diversity community of microalgae mainly diatoms and some dinoflagellates. Benthic plastics are less colononized by microorganism and they are recovered by characteristic muddy sediment from the trawled fishing grounds .The results are discussed taking into account the paramount importance to improve knowledge of the marine plastic debris dynamics and consequently their impact in the marine environment.
Keywords: Algae, Biodiversity, Fouling

Introduction
Marine debris is defined as any manufactured or processed solid material that enters the marine environment. Plastics account for the largest fraction of marine debris, which average proportion varies between 60 to 80% of total marine debris. In many regions, plastic materials constitute as much as 90 to 95% of the total amount of marine debris [1]. Apart from the widely evidenced negative effect of plastics on marine mammals, turtles and seabirds, plastics can also indirectly alter marine biodiversity by other less known actions, such as help in the introduction of alien species by floating plastics [2, 3] . Marine debris doubles the rafting opportunities for biota, assisting the dispersal of alien species [4]. This work aims to improve the knowledge of plastics debris effect both surface and bottom presenting images of the settler plastic microorganisms using the scanning electronic microscope (SEM) from areas subject to different levels of fishing impact.

Methods
Plastics were collected In the framework of the COMSOM project (CTM2008-4617).Samples were fixed in 2% glutaraldehyde. After dehydratation in etanol series, were critical point dried in liquid CO_2 , sputtered with gold-palladium and examined with a Hitachi S-3500N operated at 5 kV.

Results and Discussion
SEM microphotograph of floating plastics debris shows the substrate covered by fungi and bacteria and a very diversity community of microalgae mainly benthic diatoms of the genus *Thalasionema sp*., C*losterium sp.*, *Tabularia sp.*, *Navicula sp.*, *Achnantes sp.*, *Thalassiosira* sp., *Cylindrotheca*. Dinoflagellates and resting cyst have been observed in some occasions. SEM microphotograph of benthic plastics shows, in general, a very distinct aspect. They are recovered by characteristic muddy sediment from the trawled fishing grounds and presented a less colonized substrate by microorganism. Diatoms are present but in rare occasions. It has been observed quite often spawns of unidentified organisms. This study of the microorganism attached to plastics debris show the high potentiality of SEM analysis to study plastic debris biofouling. SEM micrographs has been applied to study biofouling organism in different interfaces, but this is the first study of SEM microphotograph applied to marine plastics debris. Plastic accumulation in the marine environment represents an extra impact source for marine biodiversity that is already threatened by other factors like climate change, overfishing and many other anthropogenic activities. But evidences are still anecdotic, which implies an urgent need of increasing our knowledge on this subject.

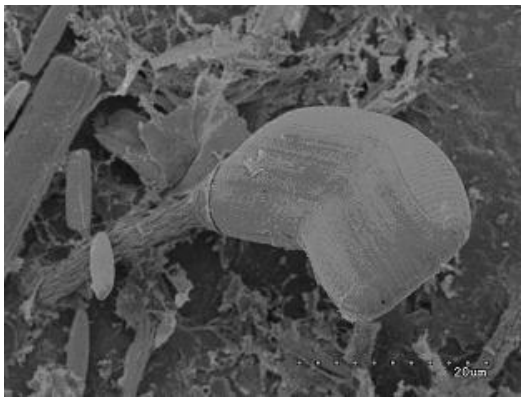


Fig. 1. Two cells of Achnanthes joined to the substract for a peduncle.

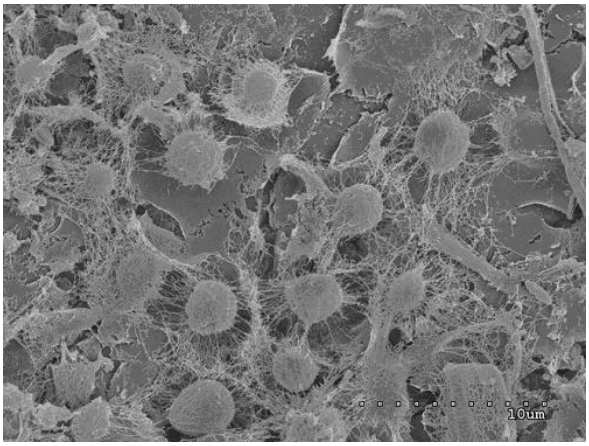


Fig. 2. Spawn of an unidentified specie on a marine plastic debris.

References
1 - Derraik JGB., 2002. The pollution of the marine environment by plastic debris: a review, *Marine Pollution Bulletin* 44: 842-852.
2 - Thiel M, Haye PA., 2006. The ecology of rafting in the marine environment. III. Biogeographical and evolutionary consequences. *Oceanography and Marine Biology* 44: 323-429.
3 - Masó M, Garcés E, Pagès F, Camp J., 2003. Drifting plastic debris as a potential vector for dispersing Harmful Algal Blooms (HAB) species. *Scientia Marina* 67: 107-111.
4 - Barnes D., 2002. Invasions by marine life on plastic debris. *Nature*: 416: 808-809.

ASSESSMENT OF THE ECOLOGICAL STATUS OF THE NORTHERN ADRIATIC COASTAL WATERS: TESTING AND ADAPTING TWO PHYTOPLANKTON INDICES

Janja France [1]* and Patricija Mozetic [1]
[1] National Institute of Biology, Marine Biology Station Piran - france@mbss.org

Abstract
As stated in the WFD, the response of phytoplankton to eutrophication of coastal waters needs to be assessed by evaluating biomass, composition and abundance, and blooms. We present the application of two indices (I_E, I_{SS}), which goes beyond the only metrics (Chlorophyll *a* concentrations) considered till now in the Mediterranean intercalibration group.
Keywords: Adriatic Sea, Phytoplankton, Monitoring, Bio-Indicators, Coastal Waters

INTRODUCTION
Few classifications of the phytoplankton ecological status of European coastal waters that consider all parameters (biomass, composition, abundance, and frequency and intensity of blooms) listed in the Water Framework Directive (WFD, 2000/60/EC), have been tentatively described to date. All attempts to construct a useful index are from coastal waters of North-East Atlantic and Baltic Sea [1, 2, 3].
Phytoplankton biomass is the only parameter that has been calibrated in the Mediterranean intercalibration group (2008/915/EC), pointing out the difficulty of describing the phytoplankton community and its changes with proper metrics especially in the relatively oligotrophic Mediterranean Sea as compared to north-western European seas. This work presents the application of two still not fully developed indices in the northern Adriatic coastal waters (Gulf of Trieste).

MATERIAL AND METHODS
Phytoplankton data were obtained during Slovenian national monitoring program at five coastal stations. Reference conditions (RC) were determined on a data set of a site in the Gulf of Trieste with slight anthropogenic influence. Assessment period of two years only (2007-2008) was considered to estimate the recent trophic conditions of five sampling stations. Two indices described by Devlin et al. [3] were tested. 1. Index of elevated phytoplankton counts (I_E) is composed of frequency of elevated Chl-*a* records, frequency of high phytoplankton counts and frequency of high count of any single taxa. 2. Index of seasonal succession (I_{SS}) assesses the shift of the seasonal cycle of phytoplankton functional groups from RC.

RESULTS AND DISCUSSION
Values of I_E separate the five stations into two groups: stations F, MA and C4 with I_E lower than reference value, and stations K and DB2 with higher values (Tab. 1). We estimate that, subjected to additional analysis, this preliminary results could be used to set the boundary between very good and good ecological status.
The second index, I_{SS}, needs an initial construction of reference standardized seasonal occurrence curves for the four functional groups. There is a difference between the values of the total I_{SS} among stations (Tab.1), but the results nevertheless offer no possibility to distinguish between ecological statuses of the stations.
We consider I_{SS} less suitable classification tool as compared to the I_E for at least two reasons. First, the stations are too similar as regards the phytoplankton community structure and, secondly, seasonal succession of phytoplankton species can be hardly assessed solely on monthly basis due to their fast generation times. There were several problems encountered during this initial phase of phytoplankton index testing. One problem is represented by the limited number of available data, e.g. two years of monthly data in comparison to 6 years assessment period foreseen in the WFD. The second and major problem relates to biomass and structural changes observed in the last decades in the phytoplankton community [4], which makes the establishment of the reference conditions a difficult task.

Tab. 1. Preliminary results of the application of two phytoplankton indices, I_E and I_{SS}, in the coastal waters of the Gulf of Trieste for the period 2007-2008.

Index I_E RC value: 16.12%					
station	F	MA	C4	DB2	K
I_E (%)	9.72	6.95	13.89	18.06	19.45
Index I_{SS}					
station					
functional group	F	MA	C4	DB2	K
nanoflagellates	91.67	91.67	87.50	91.67	95.83
diatoms	95.83	87.50	87.50	91.67	95.83
dinoflagellates	100.00	87.50	95.83	87.50	95.83
coccolithophorids	100.00	91.67	83.33	83.33	79.17
I_{SS} (%)	96.88	89.58	88.54	88.54	91.67

References
1 - Revilla M., Franco J., Bald J., Borja A., Laza A., Seoane S. and Valencia V., 2009. Assessment of the phytoplankton ecological status in the Basque coast (northern Spain) according to the European Water Framework Directive. *J. Sea Res.*, 61: 60-67.
2 - Sagert S., Krause Jensen D., Henriksen P., Rieling T. and Schubert H., 2005. Integrated ecological assessment of Danish Baltic Sea coastal areas by means of phytoplankton and macrophytobenthos. *Estuar. Coast. Shelf Sci.*, 63: 109-118.
3 - Devlin M., Best M., Coates D., Bresnan E., O'Boyle S., Park R., Silke, J., Cusack C. and Skeats J., 2007. Establishing boundary classes for the classification of UK marine waters using phytoplankton communities. *Mar. Pollut. Bull.*, 55: 91-103.
4 - France J., 2009. Long term structural modifications of the phytoplankton community of the Gulf of Trieste. Ph.D. Thesis. University of Ljubljana, Ljubljana, 160 pp.

CELLULAR AND MOLECULAR ADAPTATIONS TO MEDITERRANEAN DEEP SEA HYPER SALINES LAKES

Bruno Franzetti [1]*
[1] Institut de Biologie Structurale. UMR 5075 CNRS - franzetti@ibs.fr

Abstract

Mediterranean Deep Halophilic Anoxic lakes (DHAL's) are unique ecosystems in which microorganisms have to face hyper salinity and high pressure as main stressor agents. To understand the origin and the environmental adaptation of these halophilic microbes it is important to specify their limits of viability and the molecular modifications of their proteins. A study combining microbiology, biophysical and electron microscopy will be presented as well as a preliminary work on the characterization of a DHAL enzyme isolated by metagenomic screening.

Keywords: Salinity, Anoxia, Bacteria, Biotechnologies, Deep Sea Basins

Cellular and molecular adaptations to Mediterranean deep sea hyper salines lakes Mediterranean Deep Halophilic Anoxic lakes (DHAL's) are unique ecosystems in which microorganisms have to face hyper salinity and high pressure as main stressor agents. To understand the origin and the environmental adaptation of these halophilic microbes it is important to specify their limits of viability and the molecular modifications of their proteins. In order to investigate the possibility that the endogenous halophilic Archaeal communities found in DHAL's could be the result of surface ensemencements, we have studied the effects of salt stress on the extreme halophile *Halobacterium salinarium*. Gene expression and enzyme activity studies combined with in vivo molecular dynamics measurements (neutron diffusion) showed that low salt conditions represent a stressor equivalent to high temperature for extreme halophiles. We found however that a large proportion of the halophilic cells can survive to drasic reductions in environmental salt concentrations, first by concentrating KCl inside the cytosol and then by undergoing dramatic morphological changes. The stressed archaea were studied by electron and confocal microscopy. The result revealed cellular ultrastructural modifications that differ from other known microbial survival forms such as sporulation. The Halobacterium survival form was found to be able to resist normal sea-water conditions for long periods. A esterase from DHAL was identified from metagenomic screening by Ferrer et al. It exhibited salt and pressure-dependent activation. The corresponding ORFs was cloned in expression vectors and purified as soluble material. Biophysical measurements showed that the protein is a monomer that exists is solution as two conformational states controlled by the redox conditions. The protein is thus activated in DHAL anoxic conditions. Ferrer et al. 2005. Microbial enzymes mined from the Urania deep-sea hypersaline anoxic basin. Chemistry and Biology. 12, 895-904

References

1 - Ferrer et al., 2005. Microbial enzymes mined from the Urania deep-sea hypersaline anoxic basin. *Chemistry and Biology.* 12, 895-904

DEVELOPMENT OF A MICROARRAY-BASED ASSAY FOR THE DETECTION OF HARMFUL DINOFLAGELLATES

L. Galluzzi [1]*, A. Cegna [1], S. Casabianca [1], A. Penna [1], N. Saunders [2] and M. Magnani [1]
[1] Department of Biomolecular Sciences, University of Urbino - luca.galluzzi@uniurb.it
[2] Centre for Infections, HPA (UK)

Abstract

The high throughput, automation possibility and specificity of microarray-based detection assay, makes this technology very promising for qualitative HAB (harmful algal bloom) detection. In this study, we set up an assay based on the use of microarrays for the simultaneous detection of 9 dinoflagellate species/clades in Mediterranean Sea. The array format, hybridization and staining protocols were optimized, and the probe specificity and sensitivity were evaluated either with cultured microalgae or field samples, demonstrating the applicability of this assay for molecular monitoring of toxic microalgae.

Keywords: Monitoring, Dinoflagellates, Biotechnologies

In the last years, several molecular methods having ribosomal DNA (rDNA) as target have been developed for monitoring HAB species (mainly dinoflagellates) [1]. In this context, the use of DNA microarrays represents a promising molecular approach, able to detect simultaneously a number of DNA sequences in an unknown sample. The application of microarray technology for the detection of HAB species has been illustrated by several recent publications [2, 3, 4, 5], in which the target DNA was represented by 18S and/or 28S rDNA genes and the length of the probes immobilized on a glass slide was between 18 and 25 nucleotides. It is also noteworthy that some authors, to reduce the number of false positives, adopted a hierarchical probe approach [2, 3, 4]. In this study, a microarray-based assay for the simultaneous detection and monitoring of 9 dinoflagellate species in the Mediterranean Sea was developed. The target dinoflagellates included *Alexandrium andersoni, A. tamarense ME, A. tamarense WE, A. catenella, A. minutum, A. taylori, A. pseudogoniaulax, Protoceratium reticulatum* and *Lingulodinium polyedrum*. The species-specific probes were 45-47 nucleotides in length, and were designed on the ITS1-5.8S-ITS2 rDNA region using the software Oligoarray 2.1. These probes were designed to identify selected dinoflagellate species in the Mediterranean Sea, plus several non-Mediterranean strains. Due to probe length and the rDNA region chosen, it was not possible to adopt a hierarchical probe approach. Then, to reduce the number of false positives, two specific probes were designed for each species. Moreover, a positive control probe and a negative control probe were included as microarray performance quality control. The microarray slide format consisted in 24 subarrays, each made of 18 columns and 22 rows. A single subarray contained 10 replicates of each probe (including positive and negative control probes) for a total of 200 spots, to maximize statistical significance of the results. The target rDNA region was PCR-amplified using conserved primers, and labeled by incorporation of dUTP-biotin. Detection of the hybridized PCR products was accomplished using Cy5-streptavidin. The hybridization protocol was optimized and the specificity and sensitivity of the method were tested using genomic DNA extracted from 20 cultivated strains. The value of mean background of the entire subarray plus three standard deviations was considered as threshold for a positive signal. The probe list and the hybridization specificity results are illustrated in Fig. 1.

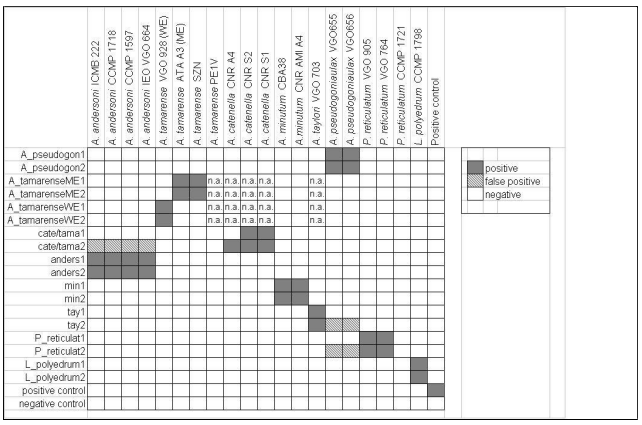


Fig. 1. Summary of specificity tests for the microarray probes (on the left). Target DNA consisted in the PCR-amplified ITS1-5.8S-ITS2 rDNA region of strains indicated in the upper part of the figure. n.a.: not available.

It is noteworthy that, when amounts of PCR product $\geqslant$100 ng of *A. andersoni* and *A. pseudogoniaulax* were used, a false positive signal appeared in probes cate/tama2, and tay2 / P_reticulat2, respectively. Nevertheless, concerning *A. pseudogoniaulax*, the false positive signals in probes tay2 and P_reticulat2 disappeared when amounts of PCR product $\leqslant$10 ng were used for hybridization. The false positive results observed in probes cate/tama2, tay2 and P_reticulat2 did not affect the reliability of the assay because the fluorescence on probes cate/tama1, tay1 and P_reticulat1 was below the threshold. The assay specificity was maintained also mixing different PCR products in the same hybridization mixture or amplifying genomic DNA extracted from 4 different *Alexandrium* species. Concerning the sensitivity of the microarray system, the species-specific probes allowed to detect up to 2 ng of labeled PCR product amplified from a DNA extracted from pure cultures. The microarray potential was tested with net samples from northern Adriatic Sea, unspiked or spiked with known amounts of target dinoflagellate species. Results confirmed the specificity observed with previous experiments and revealed the presence of *A. pseudogoniaulax* cells in Northern Adriatic (confirmed by Utermohl counts) (Fig. 2). Moreover, using spiked samples, it has been established that the sensitivity of the assay in net samples reached 1 cell/ml, with some variability from one species to another. The optimized procedure of the assay is rapid (1 working day) and allows the processing of up to 24 samples on a single slide, making microarray application attractive for monitoring programs.

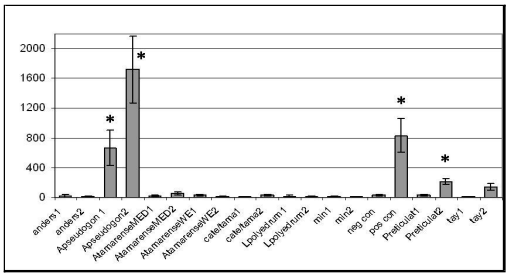


Fig. 2. Microarray analysis results of PCR products amplified from a net sample. The PCR-amplified positive control DNA (10 ng) was added in all hybridization mixtures. Asterisks indicate values above threshold

References

1 - Lin S., 2008. Use of molecular markers for early warning detection of harmful algal blooms. *Int. J. Environ. Pollut.* 33: 381 – 400.

2 - Metfies K., Berzano M., Mayer C., Roosken P., Gualerzi C., Medlin L.K. and Muyzer G., 2007. An optimized protocol for the identification of diatoms, flagellated algae and pathogenic protozoa with phylochips. *Mol. Ecol. Notes* 7:925–936.

3 - Gescher C., Metfies K. and Medlin L.K. 2008., The ALEX CHIP—Development of a DNA chip for identification and monitoring of Alexandrium. *Harmful Algae* 7:485-494.

4 - Metfies K. and Medlin L.K., 2008. Feasibility of transferring fluorescent in situ hybridization probes to an 18S rRNA gene phylochip and mapping of signal intensities. *Appl. Env. Microbiol.*74:2814-2821.

5 - Scorzetti G., Brand L.E., Hitchcock G.L., Rein K.S., Sinigalliano C.D. and Fell J.W., 2009. Multiple simultaneous detection of Harmful Algal Blooms (HABs) through a high throughput bead array technology, with potential use in phytoplankton community analysis. *Harmful Algae*, 8:196-211.

DINOFLAGELLATE CYST ASSEMBLAGES AS REPERTOIRE OF SPECIES DIVERSITY: MAIN RESULTS OF THE EU-SEED PROJECT RELATED TO MEDITERRANEAN SITES

E. Garcés [1]*, C. Satta [2], S. Anglès [1], A. Lugliè [2], F. Rubino [3], M. Giacobbe [4] and A. Penna [5]

[1] Institut de Ciencies del Mar - esther@icm.csic.es

[2] Dipartimento di Scienze Botaniche, Ecologiche e Geologiche, Via Piandanna 4, University of Sassari, 07100 Sassari, Italy

[3] Istituto per l'Ambiente Marino Costiero, CNR, Talassografico "A. Cerruti", Via Roma 3, 74100 Taranto, Italy

[4] Istituto per l'Ambiente Marino Costiero, CNR, Spianata S. Raineri 86, 98122 Messina, Italy

[5] Department of Biomolecular Sciences, University of Urbino, Viale Trieste 296, 61100 Pesaro, Italy

Abstract

Knowledge of phytoplankton species composition is important to understand bloom events in the coastal areas; it is also crucial to have information on the presence of novel and potentially introduced taxa and to confirm the recurrent events of a species. In the case of dinoflagellates, the alternation between the life stages (vegetative and resting stage) has profound implications for population dynamics. Cyst assemblages in surface sediments represent a temporally integrated repertoire of species diversity. Therefore, cyst "seedbed" maps provide baseline information for monitoring purposes, to depict geographic patterns of harmful species, and to detect the introduction of new species.

Keywords: Biodiversity, Biogeography, Life Cycles, Toxic Blooms, Dinoflagellates

Introduction

The predictability of harmful algal blooms (HABs) is one of the most complex subjects of study and one of the major setbacks is improving our knowledge of life strategies of the species and their links to the surrounding environment. Dormant cells are well-recognized stages of the life cycles of HA species. The duration of the dormant phase is often much greater than that of the multiplicative vegetative one. The dormant cells are non-motile hence, during the resting period, dispersion and concentration are determined by the same forcing functions that control the dynamic of passive particles in the water. Due to these features, the dormant stages contribute to the persistence and expansion of harmful species. In the EU SEED project, one of the objectives was focused in the mapping of cyst beds and seed populations in surface sediments to obtain information of species at several Mediterranean areas. The maps were produced in a range of locations and habitats. The focus of those surveys has been to asses the present or past biogeographic distribution of HA species.

Study areas

Sediment cores were taken by a scuba diver using cylindrical plastic corers (20 cm long with a diameter of 5 cm) in different target areas: Arenys harbour (Spain), Olbia and Siracusa bay (Italy) covering different number of stations. Samples were stored in the dark at 4°C until analysed. The sediments were processed for cyst concentration and separation from the sediment using a modified sodium polytungstate density gradient method [1] and analyzed by molecular PCR method using taxa specific primers [2].

Results and discussion

The results of the different areas analyzed showed that a tight linkage exists between pelagic and benthic domains but we also found species that were never recorded as motile stages in the water column and were present in sediments as resting cysts. This was the case of the following dinoflagellate species: *Pentapharsodinium* cf *tyrrhenicum*, *Scrippsiella crystallina*, *S. lachrymosa*, *S. precaria*, *S. trochoidea*, *Protoperidinium avellanum*, *P. claudicans*, *P. compressum*, *P. conicum*, *P.* cf *minutum*, *P. oblongum*, *P. pentagonum*, *P. subinerme*, *Zygabikodinium lenticulatum*, *Gyrodinium instriatum* and *Gymnodinium nolleri* (Figure 1).

We found that mapping the distribution of benthic stages of HA species (e.g. dinoflagellates) in superficial sediments it would allow the establishment of a baseline for the monitoring of spreading events, such as introduction of new species, and human-assisted dispersal. Embayments and hydrographically confined areas in the Mediterranean Sea act as reservoirs for planktonic dinoflagellates. During stagnant conditions, fluxes towards the sea bottom are favoured. Organic matter, cysts, and other substances accumulate in the uppermost layer of the sediments which is continually modified by addition of newly settled particles and by subsequent degradation of the accumulated material. Under these conditions, the formation of a cyst bank occurs [1, 3 and 4]. These seed banks have a high biodiversity, hosting more and/or different species of those that constitute the diversity of the vegetative population ecologically active in a present moment. Knowledge of the geographic distribution and density of cyst beds of harmful algae can help to identify risk areas under different ecological and hydrographical scenarios, providing useful information for the management of coastal
areas.

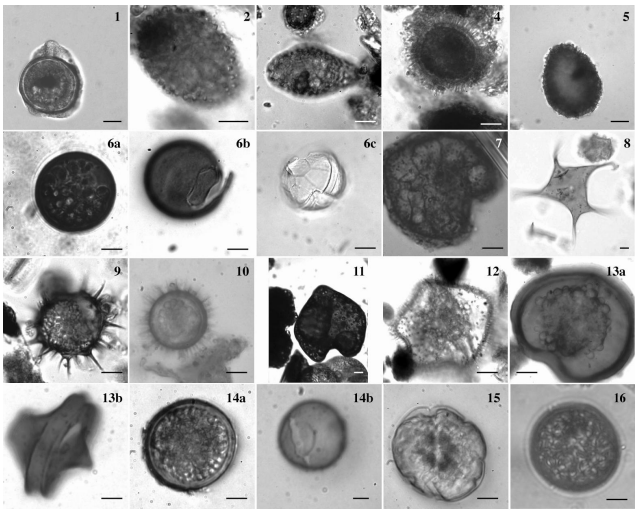


Fig. 1. *Pentapharsodinium* cf *tyrrhenicum*. (2) *Scrippsiella crystallina*. (3) *S. lachrymosa*. (4) *S. precaria*. (5) *S. trochoidea*. (6 a, b, c) *Protoperidinium avellana*: (6 a) viable cyst, (6b) empty cyst with the archeopyle, (6c) theca of the motile cell. (7) *P. claudicans*. (8) *P. compressum*. (9) *P. conicum*. (10) *P.* cf *minutum*. (11) *P. oblongum*. (12*) P. pentagonum*. (13 a, b) *P. subinerme*: (13a) viable cyst, apical view, (13 b) empty cyst, lateral view. (14 a,b) *Zygabikodinium lenticulatum*: (14 a) viable cyst, (14 b) empty cyst. (15) *Gyrodinium instriatum*. (16) *Gymnodinium nolleri*. All scale bars 10 µm

References

1 - Satta CT, Anglès S, Garcés E, Lugliè A, Padedda BM, Sechi N., 2009. Dinoflagellate cysts in recent sediments from two semi-enclosed areas of the Western Mediterranean Sea subject to high human impact. *Deep Sea Research Part II*- Topical Studies in Oceanography, doi:10.1016/j.dsr2.2009.09.013.

2 - Penna A, Battocchi C, Garcés E, Anglès S, Cucchiari E, Totti C, Kremp A, Satta C, Giacobbe MG, Bravo I, Bastianini M., 2009. Detection of microalgal resting cysts in European coastal sediments using a PCR-based assay. *Deep Sea Research Part II*- Topical Studies in Oceanography, doi:10.1016/j.dsr2.2009.09.010.

3 - Anglès S, Jordi A, Garcés E, Basterretxea G, Palanques A., 2009. *Alexandrium minutum* resting cyst distribution dynamics in a confined site. *Deep Sea Research Part II*- Topical Studies in Oceanograph, doi: 10.1016/j.dsr2.2009.09.002.

4 - Rubino F, Belmonte M, Caroppo C, Giacobbe M., 2009. Dinoflagellate resting stages from surface sediments of Syracuse Bay (Western Ionian Sea, Mediterranean). *Deep Sea Research Part II*- Topical Studies in Oceanography, doi:10.1016/j.dsr2.2009.09.011.

SPATIAL AND TEMPORARY DISTRIBUTION OF PHYTO AND BACTERIOPLANKTON COMMUNITIES IN WESTERN MEDITERRANEAN SEA. ANNUAL CYCLES AND TIME SERIES EVOLUTION.

Mª Carmen García-Martínez [1]*, Francina Moya [1], Manuel Vargas-Yáñez [1] and Patricia Zunino [1]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga - mcarmen.garcia@ma.ieo.es

Abstract
The main problem in making an appropriate description of spatial and temporal cycles of phyto and bacterioplankton is the lack of long-term studies and a wide spatial distribution. We analyze data from samples collected under RADMED monitoring program implemented by the Spanish Institute of Oceanography. Stations distributed along the Spanish coast are sampled four times a year (one per season) (fig1), from the Straits of Gibraltar to Barcelona, including Balearic islands. The seasonal cycle and time evolution of phytoplankton communities are analysed to the light of environmental information provided by this multidisciplinary program.
Keywords: Western Mediterranean, Phytoplankton, Bacteria, Monitoring, Time Series

Material and methods
The samples collected were fixed with lugol, and analyzed by inverted microscopy for identification and taxonomic composition of microphytoplankton. We focus on the study of large groups (diatoms, dinoflagellates and small flagellates). To study the smaller fraction of the phytoplankton, pico and nanoplankton and cyanobacteria (Synechococcus and Prhochlorococcus) samples were fixed on board with glutaraldehyde and immediately frozen in liquid nitrogen. The determination of the abundance of picoplankton organisms was conducted with a FACSCalibur flow cytometer (Becton & Dickinson) with a laser emission of 488 nm. At each station, samples are taken at standard depths (0, 10, 20, 50, 75, and 100). In the case of microphytoplankton, which analysis requires a strong effort, samples were only taken in areas of platform, while cytometry samples were analyzed both on platform and slope.

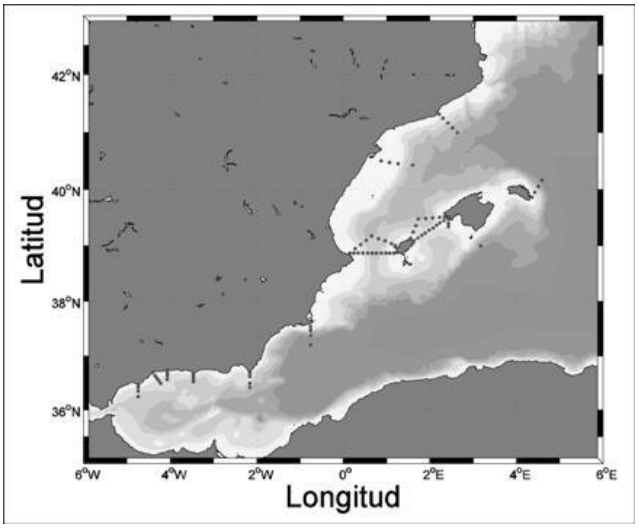


Fig. 1. RADMED monitoring program statios

The number of samples considered varies depending on the region, since there are data from previous monitoring programs to RADMED included in this study. In all stations studied, we have picoplankton cytometry and microscopy data in the period RADMED (2007-2009), while the series for microphytoplankton microscopy are longer in some areas as Alborán, in which we also have microphytoplankton data for the periods 1994-2002 and 2002-2009 and in Balearic islands from 1994 to 2000.

Results and Conclusions
Preliminary results show an increase in picophytoplankton concentration from platform to slope, reflecting offshore oligotrophic conditions. Picophytoplankton maximum abundances deepen with higher latitudes. In all the regions studied, the annual maximum is in autumn-winter, coinciding with the end of the stratification period. Regarding to microplankton composition, in all the regions we observe a dominance of diatoms and small flagellates, being more abundant in southern regions such as the Alboran Sea (fig.2), with a maximum in spring, when nutrient concentration is higher. They also describes south-north gradient with the highest abundances in the Alboran Sea area and a decrease northward accompanied by greater depth of the peak of maximum abundance.

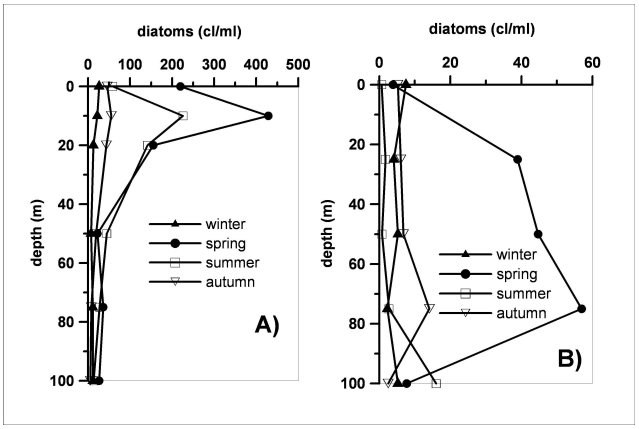


Fig. 2. Diatom mean seasonal concentration in (a) Alboran Sea and in (b) Palma de Mallorca (Balearic Islands)

References
1 - A.Reul, V.Rodriguez, F.Jimenez-Gomez, J.M.Blanco, B.Bautista, T.Sarhan, F.Guerrer,; J.Ruiz, J.Garcia Lafuente., 2005. Variability in the spatio-temporal distribution and size-structure of phytoplnkton across an upwelling area in the NW-Alboran Sea Continental Shelf Research. Vol 25. (589-608).
2 - Macias, D. Navarro, G, Echevarría, F, García C.M, Cueto, J.L., 2007. Phytoplankton pigmet distributio in the northwestern Alboran Sea and meteorological forcing: a remote sensing study. *Jounal of Marine Research*, 65, 523-543.

PICOPLANKTON ABUNDANCE AND BIOMASS DISTRIBUTION IN TURKISH SEAS

A. Gazihan Akoglu [1]*, N. Yücel [1], Z. Uysal [1], S. Tugrul [1] and E. Özsoy [1]
[1] Institute of Marine Science, Middle East Technical University, - ayse@ims.metu.edu.tr

Abstract

Comparison of the heterotrophic bacteria and cyanobacteria (*Synechococcus* sp.) abundance and biomass in highly contrasting water bodies composed primarily of the Eastern Mediterranean (Cilician and Levantine basins), the Sea of Marmara including Bosphorus and Dardanelles and the Black Sea were made within the framework of SESAME (Figure 1). Changes in picoplankton abundance and biomass in contrasting environments were investigated in relation to their unique physical, chemical and biological properties. Seawater samples were collected from the SESAME cruises carried out during spring and fall 2008.

Keywords: Marmara Sea, Eastern Mediterranean, Cyanobacteria, Bacteria

Picoplankton including photosynthetic picoplankton and heterotrophic bacteria, are important members of marine microbial food webs [1]. They are also important because of their sensitivity to environmental factors. The Mediterranean Sea, the Sea of Marmara and the Black Sea, which are connected to each other via the Turkish Strait System have very distinctive physical, chemical and biological properties. Heteretrophic bacteria and cyanobacteria (*Synechococcus* sp.) components of the picoplankton of these highly contrasting water bodies were studied (Figure 1).

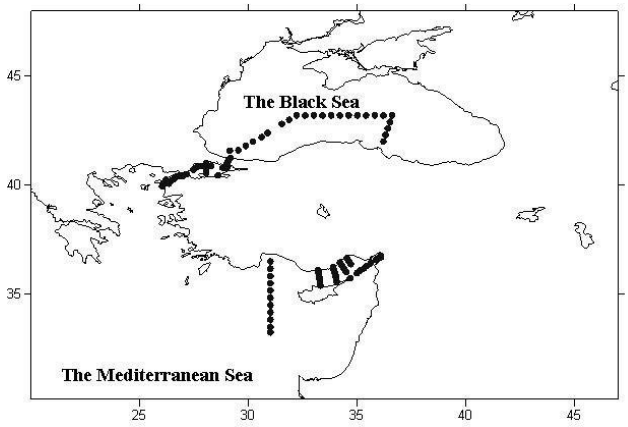


Fig. 1. Map of the stations

Seawater samples were fixed with gluteraldehide, stained with acridin orange and filtered through 0.2 µm pore sized nucleopore membrane filter. Filters covered with immersion oil were counted using an epifluorescent microscope. The Image-Pro Plus V 5.0, image analysis program was used for calculating cell volume. 77 fgC/l [2] and 120 fgC/l [3] carbon conversion factors were used for heterotrophic bacteria and cyanobacteria (*Synechoccus* sp.), respectively.

Maximum heterotrophic bacterial and cyanobacterial abundance and biomass were observed in the Sea of Marmara during fall, with the values ranging between $2.6x10^6$ cells/ml and 14.4 µgC/l for heterotrophic bacteria and $2.1x10^5$ cells/ml and 25.3 µgC/l for cyanobacteria. In contrast, lowest levels were attained during fall in the Levantine Basin with the values ranging between $4.1x10^4$ cells/ml and 0.24 µgC/l for heterotrophic bacteria and $2.5x10^1$ cells/ml and 0.02 µgC/l for cyanobacteria. Both the surface bacterial and cyanobacterial abundance and biomass averages peaked in fall compared to spring in all regions with the exception of the Sea of Marmara where an apparent decrease in heterotrophic bacterial abundance and biomass was detected.

The Sea of Marmara held the highest bacterial population during both seasons followed by the Black Sea and the Eastern Mediterranean. The Mediterranean Sea is oligotrophic and the high bacterial abundance and biomass observed in Cilician Basin is due to the sampling of productive coastal shelf waters during the cruises. Both populations were more homogenously distributed with depth during spring when the water column was mixed thoroughly.

References

1 - Joint I.R., 1986. Physiological ecology of picoplankton in various oceanographic provinces. *Can. Bull. Fish Aquat. Sci.* 214: 287– 309.

2 - Carlson C.A., Bates N.R., Ducklow H.W. and Hansell D.A., 1999. Estimation of bacterial respiration and growth effiency in the Ross Sea, Antarctica. *Aquatic Microbial Ecology*. 19: 229-244.

3 - 3. Waterburry J.B., Valois, F.W. and Franks D.G. 1986. Biological and ecological characterization of the marine unicellular cyanobacterium *Synechococcus.* In: T. Platt and W.K.W. Li (Eds), *Can. Bull. Fish. Aquat. Sci.* 214: 71-120.

SEASONAL AND SPATIAL PATTERNS OF BACTERIAL PRODUCTION, RESPIRATION AND GROWTH IN THE E. MEDITERRANEAN AND THE MARMARA SEA.

A. Giannakourou [1]*, P. Pitta [1], I. Magiopoulos [1], A. Konstadinopoulou [1], C. Zeri [1], E. Krassakopoulou [1], V. Avgoustidi [1] and E. Papathanassiou [1]

[1] Hellenic Center for Marine Research (HCMR) - agiannak@ath.hcmr.gr

Abstract

Bacterial production (BP), respiration (BR) and growth efficiency (BGE) were investigated in the upper 150m along a transect from Ionian to the Marmara Sea including the Dardanelles, during the SESAME cruises in early spring (March 2008) and late summer (September 2008) and the Alliance_TSS08 cruise (September 2008). Bacterial growth efficiency was highly variable, suggesting that several factors (DOC and inorganic nutrients) control BGE. The largest amount of carbon taken up by bacteria (85-99%) was not used for biomass production and was respired as CO2.

Keywords: Bacteria, Eastern Mediterranean, Marmara Sea

Bacterioplankton play a central role in the biological transfer of carbon in the ocean through the microbial loop [1], however bacterial processes have poorly been studied in the E. Mediterranean. In this study we report results from bacterial production (BP), respiration (BR) and growth efficiency (BGE) along a transect from Ionian to the Marmara Sea, including the Dardanelles straits. North Aegean is the area where Black Sea waters (BSW) of low salinity and low temperature enter the Mediterranean through the Dardanelles straits and intense interaction of different water masses, within a relatively small area, takes place [2]. Samples were taken on board the R/V Aegaeo and Alliance, in early spring (March 2008) and late summer (September 2008) covering 15 stations at the oligotrophic seas of the E. Mediterranean (Ionian, Cretan, Libyan and Aegean Sea), 2 stations at the Dardanelles straits and 4 stations at the Marmara Sea. BP and BR were measured by 3H-leucine incorporation, conducted at saturating (20nM Leu) concentrations [3] and by an automated Winkler titration method respectively. BGE was calculated using the formula BP/(BP+BR), assuming RQ=1 [4]. BP ranged 0.13 - 52.82 ngC l^{-1} h^{-1} in the E. Mediterranean and increased in March at the Aegean stations, with peak values at the surface layers of North Aegean, as influenced by the Black Sea water. In September BP values varied between 0.79 to 73.08 and 0.5 to 97.42 ngC l^{-1} h^{-1} at Dardanelles straits and the Marmara Sea, while the increased surface values were not detected at the N. Aegean water (Fig 1).

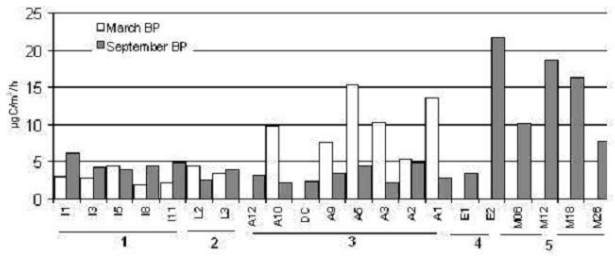


Fig. 1. Mean depth integrated values of bacterial production (BP) along the transect from Ionian (1), Libyan (2), Aegean Sea (3), to Dardanelles straits (4) and the Marmara Sea (5), in March and September 2008

Dissolved organic carbon (DOC) ranged 50-155 μmol l^{-1}. High values of DOC were encountered in Black Sea waters outflowing the Dardanelles Strait and occupying the surface layer of North Aegean (92-155 μmol l^{-1} in March and 81-132 μmol l^{-1} in September). Simultaneously in September increased values of DOC were recorded at the surface layer of Dardanelles straits and Marmara Sea (162-213μmol/l) (Zeri C., unpublished data). Bacterial respiration ranged 0.40 – 36.56 μM O_2 h^{-1}, the amount of carbon respired was 0.23 – 9.97 μM C d^{-1}. Using both these BR and BP values, we calculated the BGE and it ranged from 1%– 19% (Fig 2).

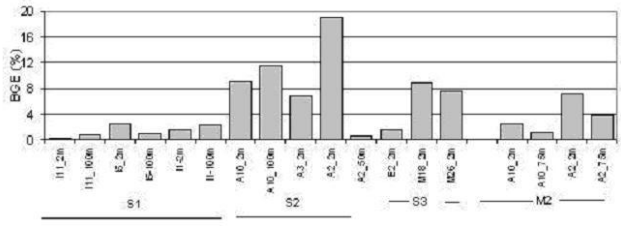


Fig. 2. Bacterial Growth Efficienty (BGE) at selected stations and dephts from Ionian to Marmara Sea. S=September, M=March, 1=Ionian Sea, 2= Aegean Sea, 3=Dardanelles Straits and Marmara Sea

Bacterial growth efficiency was highly variable, suggesting that several factors (DOC and inorganic nutrients) control BGE. The largest amount of carbon taken up by bacteria (85-99%) was not used for biomass production and was respired as CO2. Thus bacteria act more as a 'sink' of organic carbon to higher trophic levels. E. Mediterranean is a complex marine environment and bacteria biomass and growth are controlled by several factors. Studies which used BGE values of 30% would have significantly underestimated the carbon flux through bacteria.

Acknowledgements The present study was conducted within the framework of the European IP project FP6_Sesame EC contract No GOCE-036949. The data collected during the NRV Alliance cruise to the area was made possible by the TSS Protocol, including as Participants the NATO Undersea Research Centre (NURC) and Turkish Navy Office of Navigation, Hydrography and Oceanography.

References

1 - Azam F., 1998. Microbial control of oceanic carbon flux: the plot thickens. *Science* 280: 694-696.

2 - Zervakis, V. and Georgopoulos, D., 2002. Hydrology and circulation in the North Aegean (eastern Mediterranean) throughout 1997 and 1998. *Mediterr. Mar. Sci.*, 3: 5-19.

3 - Kirchmann D.L., 1993. Leucine incorporation as a measure of biomass production by heterotrophic bacteria. *In:* Kemp PF, Sherr BF, Sherr EB and Cole (eds), Handbook of Methods in Aquatic Microbial Ecology. Lewis, Boca Raton, pp 509-512.

4 - Del Giorgio P. A. and Cole J.J., 1998. Bacterioplankton growth efficiency in aquatic systems. *An. Rev. Ecol. System.* 29: 503-541.

REMINERALIZATION PROCESS IN A NUTRIENT-PHYTO-ZOOPLANKTON-BACTERIA MODEL

Jean-Marc Ginoux [1]*, Bruno Rossetto [1], Jean-Louis Jamet [1] and Dominique Jamet [1]
[1] Université du Sud - ginoux@univ-tln.fr

Abstract

Seasonal variations of plankton communities in the Toulon Bay (Var, France) have been studied since 1995 [1, 2] and samplings have been carried out regularly. The abundance of phytoplankton (P), zooplankton (Z) and nutrients concentration (N), *i.e.* average concentrations of nitrates and orthophosphates have lead to a three-trophic model [3]. Since 2005, bacteria average concentrations (B) have been also evaluated to take into account their influence on plankton communities in the remineralization process. Thus, the aim of this article is to propose the most simple and consistent Nutrient-Phyto-Zooplankton-Bacteria model transcribing this process. Then, regarded as a dynamical system its mathematical features are highlighted.
Keywords: Population Dynamics, Nutrients, Phytoplankton, Zooplankton , Bacteria

The biological point of view

The classical three-trophic food chain [6] can be modelled by interactions of predator-prey type which consist of a top-predator (Z) which can graze on phytoplankton (P) which on its turn can predate on nutrients (N). But, bacteria can break down into utilizable nutrient, a process known as remineralisation [4]. Then, zooplankton can graze either upon phytoplankton or bacteria or both. Many models have been already developed in order to transcribe such behaviour [4] but the functional responses that involve make their mathematical study and biological interpretation difficult. So, starting from such seminal works the most simple and consistent NPZB model is proposed.

Modelling

Let's consider the classical Volterra predator-prey model [5, p.88] for a three trophic level interaction involving nutrients (N), phytoplankton (P) and zooplankton (Z) and let's include bacteria (B). This NPZB model does not include any functional response with limitation such as Holling type II or type III [4] since it can be considered that bacteria are playing the role of limiting factor in the evolution of this system. By considering that the remineralisation process can be modelled by an interaction of predator-prey type two terms are added to the nutrients growth: PB and ZB which correspond to the transformation of phyto and zooplankton losses into nutrients by the bacteria. Of course such terms represent an uptake for the bacteria. The most simple and consistent NPZB model is thus built with a parameter set chosen in a biological range.

Mathematical aspects

The behaviour of such dynamical system transcribes the evolution of each of its components. And since for certain parameter values this singularly perturbed system has three times scales the rates of change for the prey (N), the predator (P), the top-predator (Z) and the bacteria (B) range from fast to intermediate to slow, respectively [7]. The slow manifold analytical equation on which the trajectory lies (limit cycle or chaotic attractor) is provided according to a new method developed in [8]. Then, a state analytical equation involving the four variables is established.

References

1 - Jamet J.-L. & Ferec-Corbel A.-S., 1996. Seasonal variations of the zooplankton community in a littoral marine ecosystem : Toulon Bay (Var, France), *Mar. Life*, 6(1-2), 15-20.

2 - Jamet J.-L., Bogé G., Richard S., Geneys C. & Jamet D., 2001. The zooplankton community in bays of Toulon area (northwest Mediterranean Sea, France), *Hydrobiologia*, 457,155-165.

3 - Ginoux J.-M., Rossetto B. & Jamet J.-L., 2005. Chaos in a three dimensional Volterra-Gause model of predator-prey type, Int. *J. Bif. & Chaos*, 5(15), 1689-1708.

4 - Edwards, A., 2001. Adding detritus to a nutrient-phytoplankton-zooplankton model: a dynamical-systems approach, *J. Plankton Res.* 23 (4), 389–413.

5 - Volterra V., 1931. Leçons sur la Théorie Mathématique de la Lutte pour la Vie, Gauthier-Villars, Paris.

6 - Holling C.S., 1959, Some characteristics of simple types of predation and parasitism, *Can. Entomologist*, 91, 385-398.

7 - Deng B., 2001, Food chain chaos due to junction-fold point, *Am. Inst. of Physics*, 11 (3), 514-525.

8 - Ginoux J.-M., 2009. Differential Geometry Applied to Dynamical Systems, World Scientific Series on Nonlinear Science, Vol. 66, series A.

PHYTOPLANKTON COMMUNITY STRUCTURE AND SUCCESSION ALONG THE EASTERN PART OF THE NORTHERN ADRIATIC SEA

J. Godrijan [1]*, D. Maric [1], M. A. Pfannkuchen [1], T. Đakovac [1], D. Degobbis [1] and R. Precali [1]
[1] Centre for Marine Research, Rudjer Boškovic Institute, Rovinj, Croatia - jelena.godrijan@irb.hr

Abstract
Biological and hydrochemical properties were investigated monthly on seven stations in the coastal waters of the eastern part of the northern Adriatic Sea for the period 2008/2009. The characterization of phytoplankton community revealed apparent growth periods.
Keywords: Phytoplankton, Adriatic Sea, Coccolithophores, Diatoms, Dinoflagellates

Introduction
The phytoplankton abundance and seasonality in the eastern part of the northern Adriatic (NA) are well described, and directly depend upon input of nutrients (related to the annual regime of the Po River discharge), and distinct physical processes ([1], [2], [3]). The eastern part of the basin is characterised by a different hydrological regime thus showing exceptions to the described trends of phytoplankton succession.

Materials and Methods
The study was performed along the Istrian peninsula, eastern NA, one mile from the coast (Fig.1). Samplings were performed monthly during the 2008/09 period on seven stations. Water samples were collected with a 5-l Niskin bottle sampler at surface, 10m and 2m above the bottom. Subsamples for nutrient concentrations were analyzed by spectrophotometric methods [4]. Subsamples for phytoplankton community characterization were analyzed microscopically with the inverted microscope method [5] using a Zeiss Axiovert 200 model. A Total of 210 samples were analysed. For statistical analysis Systat 12 was used.

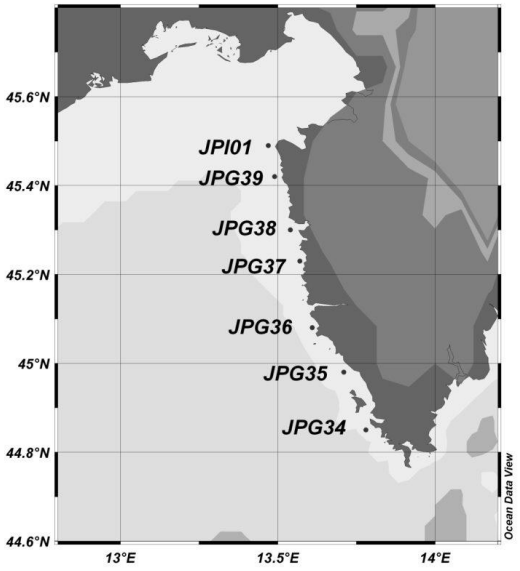


Fig. 1. Map of the investigated area

Results and Discussion
Recognisable microphytoplankton comprised 165 taxa; 97diatoms, 50 dinoflagellates, 16 coccolithophorids, and 2 silicoflagellates. A seasonal cycle was determined, together with several distinct periods which were characterized by high counts of major phytoplankton groups (Fig. 2).

Annual structure of phytoplankton succession was as follows:
January: coccolithophorids (up to 60%). The most dominant species at all stations was *Emiliania huxleyii* (max $4.4x10^5$ cells/l). An early bloom of *Skeletonema marinoi* (max $5.9x10^5$ cells/l - JPI01 surface) was observed on the two northernmost stations.

February-April: nanoplankton (up to 76% in April). Dominant species: *Emiliania huxleyii* and *Pseudo-nitzschia delicatissima* complex. In March a bloom of *Prorocentrum minimum* (max $1.9x10^4$ cells/l) occurred.

June-August: diatoms (up to 68%), coccolithophorids (up to 30%). A rich composition of dinoflagellates in both nano and micro fraction was observed. In July a diatom peak included *Chaetoceros sp.* (max $3.6x10^5$ cells/l), and *Pseudo-nitzschia delicatissima* complex (max $1.5x10^5$ cells/l).

September–November: diatoms (up to 80%). Dominant species were *Pseudo-nitzschia delicatissima* complex and *Chaetoceros sp.* complex. Through the whole profile *Chaetoceros socialis* prevailed in the bottom layer.

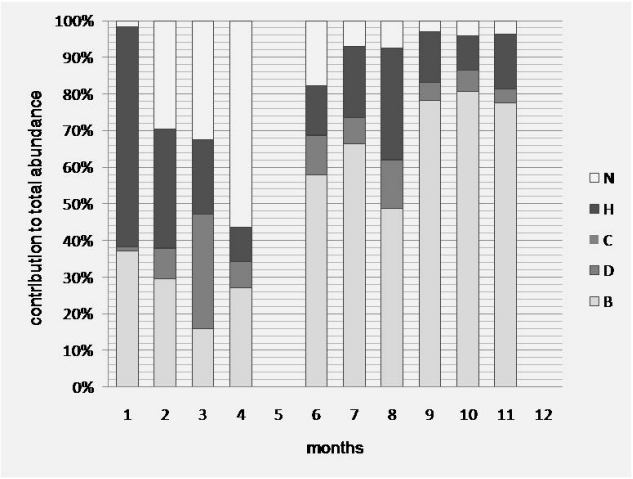


Fig. 2. Contribution of the major phytoplankton groups (N=nanoplankton, H=coccolithophorids, C=silicoflagellates, D= dinoflagellates, B= diatoms)

Although a monthly sampling strategy does not offer the best temporal resolutions to appreciate the actual annual cycle of phytoplankton, the seasonal blooms were apparent. The noted exceptions to the western part of NA [3] were: (i) a significant portion of coccolithophorids in the community throughout the whole investigated period, and (ii) absence of the diatom bloom usually noted in spring.

References
1 - Zavatarelli M., Baretta J.W., Baretta-Bekker J.G. and Pinardi N., 2000. The dynamics of the Adriatic Sea ecosystem. An idealized model study. *Deep-Sea Res I*, 47: 937-970.
2 - Gilmartin, M. and Revelante, N., 1980. Nutrient input and the summer nanoplankton bloom in the northern Adriatic Sea. *Mar. Ecol.*, 1(2): 169-180.
3 - Bernardi Aubry, F., Berton, A., Bastianini, M., Socal, G. and Acri, F., 2004. Phytoplankton succession in a coastal area of the NW Adriatic, over a 10-year sampling period (1990–1999). *Cont. Shelf Res.*, 24: 97–115.
4 - Strickland, J.D.H., Parsons, T.R., 1972. A practical handbook of seawater analyses. *Fish. Res. Bd. Can. Bull.*, 167: 1-310.
5 - Utermöhl, H., 1958. Zur Vervollkommung der quantitativen Phytoplankton Methodik, *Mitt. Int. Ver. Theor. Angew. Limnol.*, 9: 1–38.

DEVELOPMENT OF NEW BIOASSAYS TO ASSESS THE QUALITY OF COASTAL AND ESTUARINE ENVIRONMENTS: THE POTENTIAL OF THE COSMOPOLITAN MARINE PROTOZOA *EUPLOTES CRASSUS*

Alessio Gomiero [1]*, Lara Boatti [2], Cristina Nasci [1] and Aldo Viarengo [2]
[1] Thetis S.p.A. - alessio.gomiero@thetis.it
[2] Department of Environmental and Life Sciences, University of Eastern Piemonte "Avogadro", Via Bellini 25G, 15100 Alessandria, Italy.

Abstract
Estuarine and coastal sediments represent the final destination of thousands of organic and inorganic pollutants which are continuously discharged into the environment as result of industrial, agricultural and domestic activities. Due to the complexity of this environmental compartment sole chemical characterization often fails to correctly estimate the toxicity of such complex matrix. In such a context, a multi-disciplinary, chemical-biological approach can overcome this lack providing useful information for identifying those situations which require a close investigation at an early stage. In this work, the possibility of utilizing the interstitial marine ciliate *Euplotes crassus* (Dujardin, 1840) was examined for the screening of polluted estuarine sediments, pore and interstitial water by laboratory and field experiments.
Keywords: Bio-Indicators, Ecotoxicology, Sediments, Pollution, Monitoring

Contamination of the aquatic environments by pollutants has become a serious problem in the recent years. Furthermore, it has been observed that the pollutant concentration in sediments and sediment's interstitial water can be more than 10-100 times higher than the one present in the overlying water column. Hence, the interest in the toxicity of pollutants occurrence in these matrices and their biological effects, has increased during the last decades as they enter waterways by runoff, atmospheric deposition etc., and may be transported to estuaries and coastal sites potentially causing harm to a large variety of non-target wildlife organisms. On this context, it is generally agreed that in the field of environmental biomonitoring biomarkers can provide useful information for pointing out those situations requiring a close investigation at an early stage [1]. From this point of view, it is of increasing interest to identify a panel of organisms displaying sensitive responses to sediment and pore water from coastal environments under anthropic pressure.

Thus, the possibility of utilizing *E. crassus*, an interstitial single-cell marine protozoa, was examined by applying a battery of tests including cell viability and growth as typical ecotoxicological high-level endpoints. This study was also addressed to detect more sensitive sublethal early-warning responses utilising biological parameters such as lysosomal membrane stability and endocytotic rate, which are typical stress biomarkers in eukaryotic cells [2]. The sensitivity of *E. crassus* assay has been assessed within a range of organic and inorganic chemicals concentration and mixtures of them. Two heavy metals species were selected, one essential (Cu) and a non-essential (Hg), since it has been suggested that heavy metals may block enzyme systems of microorganisms or interfere with some essential cellular metabolites of bacteria and protozoa [3]. Furthermore, benzo(a)pyrene was involved as organic pollutant model. A field application was also performed aiming to validate the proposed bioassay. Four sampling sites within the Venice Lagoon were chosen according to previously reported differences in both environmental conditions and level of anthropic pressure [4, 5].

Results of laboratory studies indicated that estimated sub-lethal index of stress presented significant differences between reference and treated animals even after exposure to nano/micro molar trace elements concentrations. The endocytotic rate data showed a particularly strong decrease of predation capability in organisms treated with Hg. Sub-lethal tests, like endocytosis rates and lysosomal membrane stability, were able to detect biological effects of n/µM concentrations of toxicants. Furthermore, a significant synergic effect was observed on lysosomal membrane stability and replication rate of ciliate protozoa exposed to binary mixtures of selected toxicants. The results of field samples were in agreement with the laboratory responses. The overall results confirmed the suitability of using *E. crassus* as sentinel organism for monitoring sediment toxicity and provided an ecotoxicological protocol based on cellular biomarkers for the early detection of biological disturbance [6].

References
1 - Cajaraville M. P., Bebianno M. J., Blasco J., Porte C., Sarasquete C., Viarengo A., 2000. The use of biomarkers to assess the impact of pollution in coastal environments of the Iberian Peninsula: a practical approach. *The Sci. of The Tot. Env.*, 247, 2-3: 295-311.
2 - Moore M. N., Icarus A. J., McVeigh A., 2006. Environmental prognostics: An integrated model supporting lysosomal stress responses as predictive biomarkers of animal health status. *Mar. Env. Res.* 61, (3): 278-304.
3 - Morgan, G.B., Lackey, J.B., 1958. BOD determination in wastes containing chelated copper and chromium. *Sewage Ind. Wastes* 30: 283-286.
4 - Losso C., Arizzi Novelli A., Picone M., Marchetto D., Pessa G., Molinaroli E., Ghetti P. F., Volpi Ghirardini A., 2004. Evaluation of surficial sediment toxicity and sediment physico-chemical characteristics of representative sites in the Lagoon of Venice (Italy). *J. Mar Sys.* 51, (1-4): 281-292.
5 - Nesto N., Romano S., Moschino V., Mauri M., Da Ros L., 2007. Bioaccumulation and biomarker responses of trace metals and micro-organic pollutants in mussels and fish from the Lagoon of Venice, Italy. *Mar. Poll. Bull.* 55, (10-12): 469-484.

PHYTOPLANKTON CARBON-BIOMASS IN THE MEDITERRANEAN SEA

Olympia Gotsis-Skretas [1]* and Lydia Ignatiades [2]
[1] Hellenic Center for Marine Research - ogotsis@ath.hcmr.gr
[2] National Centre for Scientific Research "Demokritos", Institute of Biology

Abstract

In this study, we defined the phyto-carbon derived from 63 phytoplankton samples (216 species) collected from 9 stations and 7 depths located along a large scale (3188 Km) east-west longitudinal area (4°95'E - 32°67'E) of the Mediterranean Sea, in summer 1999. Species identifications and cell dimension measurements for cell bio-volume calculations [1] were performed in an inverted microscope. Conversion of cell bio-volume to cellular carbon-content was made with the application of equations found in the literature [2], [3].

Keywords: Phytoplankton, Carbon, Biomass

Quantifying the carbon content of phytoplankton cells is essential, because carbon is the main parameter used in models and in flux and budget studies for understanding the structure and dynamics of marine ecosystem and for evaluating the role of the ocean in global carbon cycles. A synopsis of the results of the present investigation are given in Tables 1 and 2. The average cell concentrations (Table 1) did not differ among the three dominant phytoplankton taxa since they were for diatoms: 4.45×10^3 cells.L^{-1} (30.7%); for dinoflagellates: 4.67×10^3 cells.L^{-1} (35.9%); and for coccolithophores: 4.17×10^3 cells.L^{-1} (33.3%). However, the average cell carbon content among these taxa (Table 2) showed significant differences because dinoflagellates contributed the maximal cell carbon content (average:18.71 µgC.L^{-1}; 71.3%), the coccolithophores the minimal carbon content (average:0.38 µgC.L^{-1}; 2.2%) and the diatom's relevant average was 6.15 µgC.L^{-1} (26.5%).

Tab. 1. All stations' means and ranges of phytoplankton abundance (cells.L^{-1} and % of total) for the three main phytoplankton groups along the east-west Mediterranean.

Taxa	Mean (Cells.L^{-1})	Range (Cells.L^{-1})	Mean (%)	Range (%)
Diatoms	4.45×10^3	$3.29 \times 10^2 - 1.17 \times 10^4$	30.7	3.2 – 54.2
Dinoflagellates	4.67×10^3	$2.97 \times 10^3 - 7.82 \times 10^3$	35.9	22.2 – 52.2
Coccolithophores	4.17×10^3	$2.04 \times 10^3 - 6.15 \times 10^3$	33.3	9.5 – 51.8
Total Phytoplankton	1.33×10^4	$1.03 \times 10^4 - 2.15 \times 10^4$		

Tab. 2. All stations' means and ranges of cell carbon (µg.L^{-1} and % of total) for the three main phytoplankton groups along the east-west Mediterranean Sea.

Taxa	Mean (µg C.L^{-1})	Range (µg C.L^{-1})	Mean (%)	Range (%)
Diatoms	6.15	0.72 – 18.81	26.5	6.2 – 64.6
Dinoflagellates	18.71	5.68 – 64.02	71.3	34.4 – 89.1
Coccolithophores	0.38	0.20 – 0.58	2.2	0.4 – 4.7
Total phytoplankton	25.24	11.71 – 75.54		

These data show that dinoflagellates were more carbon dense than diatoms and coccolithophores because of their bigger cell volume and confirm the information from the literature on the positive relationship of biovolume and carbon biomass in phytoplankton. The results also demonstrate the importance of dinoflagellates in the foodweb chain and the carbon cycle of the oligotrophic Mediterranean Sea during summer.

References

1 - Hillebrand H., Durselen C.D., Kirschtel D., Pollingher U. and Zohary T., 1999. Biovolume calculation for pelagic and benthic microalgae. *J. Phycol.*, 35: 403-424.

2 - Llewellyn C.A. and Gibb S.W., 2000. Intra-Class variability in the carbon, pigment and biomineral content of prymnesiophytes and diatoms. *Mar. Ecol. Prog. Ser.*, 193: 33-44.

3 - Menden-Deuer S. and Lessard E.J., 2000. Carbon to volume relationships for dinoflagellates, diatoms and other protist plankton. *Limnol. Oceanogr.*, 45: 569-579.

ETUDE PAR CYTOMETRIE EN FLUX DE LA DISTRIBUTION SPATIALE DU PEUPLEMENT MICROBIEN DANS LE GOLFE DE GABES

I. Hamdi [1]*, A. Zouari [2], A. Hamza [3], S. Maalej [1], M. Denis [4] and A. Bouain [5]

[1] Laboratoire de Microbiologie. Faculté de sciences de Sfax, 3000, Tunisie - ineshhamdi@yahoo.fr

[2] Laboratoire milieu marin , Institut National des Sciences et Technologie de la Mer, 2025 Salammbô, Tunisie

[3] Laboratoire milieu marin, Institut National des Sciences et Technologies de la Mer, Sfax, 3018, Tunisie

[4] Laboratoire de Microbiologie, géochimie et écologie marines, CNRS_UMR 6117, Université de la Méditerranée, Centre d'Océanologie de Marseille, 13288 Marseille, France

[5] UR 05 ES 05 Biodiversité et écosystèmes aquatiques. Faculté de sciences de Sfax, 3038 Sfax. Tunisie

Abstract

Dans le Golfe de Gabès, les travaux effectués sur le phytoplancton et l'ultraphytoplancton en particulier, sont assez récents et peu nombreux [1], d'où le manque d'informations et de données. L'application de nouvelles techniques telles que la cytométrie en flux nous permet d'étudier l'action des facteurs physico-chimiques sur la distribution des populations bact ériennes et ultraphytoplanctoniques.

Keywords: Cyanobacteria, Gulf Of Gabes, Phytoplankton, Nutrients

Matériel et méthodes :

La cytométrie en flux est une technique d'identification permettant de mesurer les paramètres de diffusion, de diffraction et de fluorescence de cellules individuelles dans une population en suspension monodisperse. Cette technique est caractérisée surtout par sa rapidité d'analyse (jusqu'à plusieurs milliers de cellules par seconde), sa sensibilité, sa précision, ainsi que par sa simplicité. Cette étude de la distribution spatiale des populations bactériennes et ultraphytoplanctoniques par cytométrie en flux entre dans le cadre du projet intitulé « POEMM » (Planktonic and Oceanographic Ecosystem Monitoring and Management), fondé par l'Institut National des Sciences et Technologies de la Mer en Tunisie. La zone d'étude est située dans le Gofle de Gabès (Sud de la Tunisie), entre 33°N-36°N et 10°E-13°E et comporte 23 stations d'échantillonnage. La campagne a été effectuée à bord du navire de recherche océanographique et halieutique « Hannibal R/V », en juin 2008. Le prélevement d'eau de mer a été fait à 3 niveaux de la colonne d'eau (surface, milieu de la colonne d'eau et fond) pour les stations côtières, d'une profondeur inférieure à 50 m, et à 5 niveaux (surface, -10 m, -20 m, thermocline et fond) pour les stations de profondeur supérieure à 50 m.

Résultats et discussions :

L'analyse de l'ultraphytoplancton montre la présence d'eucaryotes (picoeucaryotes et nanoeucaryotes). En ce qui concerne les cyanobactéries, *Synechococcus* est présent de façon importante, alors que *Prochlorococcus* est moins abondant. Toutefois, une nouvelle population de cellules prédatrices de grandes tailles se distingue des autres groupes cellulaires. Ce groupe semble original et caractéristique du Golfe de Gabès. L'analyse du bactérioplancton montre la richesse du milieu en ces cellules hétérotrophes, avec présence de deux groupes cellulaires (HNA : High Nucleic Acid) et (LNA : Low Nucleic Acid), la distribution de ces deux populations est variable en fonction de la profondeur. Ces résultats de distribution des différentes populations bactériennes et ultraphytoplanctoniques sont discutés en fonction de la distribution des facteurs physicochimiques au niveau de la zone d'étude.

References

1 - Drira Z., Bel Hassen M., Hamza A., Rebai A., Bouain A., Ayedi H., and Aleya L., 2009. Spatial and temporal variations of microphytoplankton composition related to hydrographic conditions in the Gulf of Gabes. Journal of the marine Biological.

TROPICAL HARMFUL PHYTOPLANKTON SPECIES ALONG ABRUZZO COAST (W ADRIATIC)

Cristina Ingarao [1]* and Tommaso Pagliani [1]
[1] Mario Negri Sud Institute – Via Nazionale 8/a – 66030 Santa Maria Imbaro (CH), ITALY - ingarao@negrisud.it

Abstract
The presence of tropical harmful species along the Abruzzo coast (Western Adriatic Sea) belong to 2007 when it was revealed the first appearance of *Prorocentrum lima* species. After that summer, other tropical toxic species such as *Ostreopsis ovata*, *Coolia monotis* and *Prorocentrum concavum* were observed. Besides, the ichtyotoxic species from Japan sea (*Fibrocapsa japonica*) has been detected before 2007. These species are known to produce toxins that could be dangerous for human health. In this study four coastal rocky points have been monitored during the summers 2007, 2008 and 2009. Chemical - physical parameters of sea water have been measured in order to understand their relationship with the presence/absence of tropical harmful species.
Keywords: Algae, Toxic Blooms, Toxins, Phytoplankton, Species Introduction

Introduction
O. ovata is a common species of tropical areas. Its occurrence in coastal areas of the Adriatic Sea (Gulf of Trieste, Conero Riviera and Abruzzo coast) has probably been favoured by the increased water temperatures of the last decade [1]. It clearly poses increasing risks for human health and effects on benthic communities. In most cases *O. ovata* was present in association with other potentially toxic dinoflagellates such as *P. lima* and *C. monotis*,belonging itself from tropical areas [2]. Blooms of *F. japonica* in the Adriatic Sea, instead, have been regularly observed since 1997, above all in summer periods (July - August). Among the 5000 species of marine phytoplankton, almost 300 species can occur in such high numbers that they obviously discolour the surface of the sea, while only 80 species have the capacity to produce potent toxins dangerous for humans [3].

Methods
This work underlines the presence of tropical harmful species of the Abruzzo coast. The investigations were carried out in four confined areas such as harbors and rocky banks during the periods of June, July, August and September of 2007, 2008 and 2009 years. These stations have been selected above all to localize epiphytic species like *P. lima*, *C. monotis*, *O. ovata* and *P. concavum* due to their behavior to live on macroalgae, on sediments and inside stagnant environment with absence of water movements. At each station, one seawater sample was taken at 0.5 m from the surface by means of a pump. Algae observations were effected by the use of the light microscope (ausJENA Telaval 3) at 200x, 400x and 1000x magnification (Fig 1). Cells abundance concentrations were all expressed as cells $\cdot L^{-1}$, reading the entire well using a volume of 50 ml. Chemical - physical parameters of seawater were measured by a multiparametric probe.

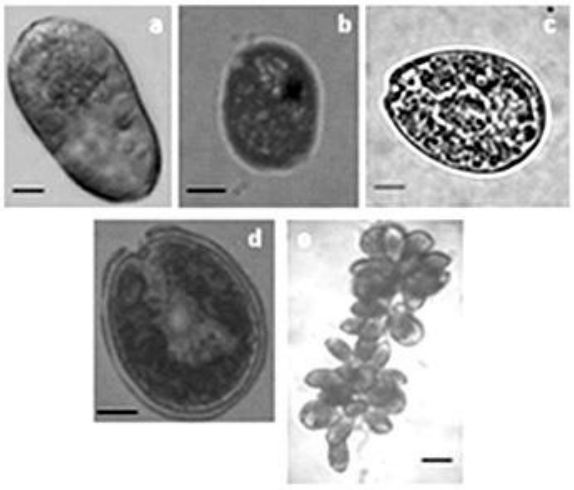


Fig. 1. 1000x magnification, scale bar 10 µm: a) *F. japonica*; b) *C. monotis*; c) *P. lima*; d) *P. concavum.* 200x magnification, scale bar 50 µm: e) *O. ovata*

Results
The first appearance of *P. lima* was recorded on summer 2007 only inside Ortona harbor. Its cellular abundance has been detected for the entire season (June, July, August and September) with a mean concentration of 1.9×10^5 cells $\cdot L^{-1}$. The first appearance of *O. ovata*, instead, was at the end of August 2008, at Ortona harbor and Fossacesia rocky bank. Its mean abundance was 3.4×10^5 cells $\cdot L^{-1}$. *P. concavum* and *C. monotis* have been detected for the first time during this last summer (August and September 2009) always at Ortona harbor, with 1.5×10^3 and 3.0×10^2 cells $\cdot L^{-1}$ mean concentrations respectively. *F. japonica*, at last, has always been detected for the entire period of monitoring, with a bloom phenomenon on August 2009 along the entire coast of study (6.8×10^4 cells $\cdot L^{-1}$ mean abundance).

Discussion and Conclusions
The increase of sea water temperature and the expand of ships traffic and their ballast waters have caused the entry of several tropical harmful microalgae. In fact, the Ortona harbor point, characterized by a major ship traffic, has revealed the entire community of the species in study among the four sampling stations. Besides, the highest temperature values of the three years of monitoring were always measured on August. During these periods, the contemporary presence of the 5 tropical harmful species has been registered.

References
1 - Russo, A., Rabitti, S., Bastianini, M., 2002. Decadal climatic anomalies in the Northern Adriatic Sea inferred from a new oceanographic data set. *P.S.Z.N.: Marine Ecology*, 23 (Suppl. 1): 340-351.
2 - Sansoni, G., Borghini, B., Camici, G., Gasotti, M., Righini, P., Fustighi, C., 2003. Fioriture algali di *Ostreopsis ovata* (Gonyaulacales: Dinophyceae): un problema emergente. *Biol. Amb*. 17: 17-23.
3 - Hallegraeff, G.M., 2003. Harmful algal blooms: a global overview. *In:* Hallegraeff, G.M., Anderson, D.M., Cembella, A. (Eds.), Manual on Harmful Marine Microalgae. UNESCO Publishing, Paris, pp. 25-49.

ULVA INTESTINALIS ASSOCIATED BACTERIA: MOLECULAR IDENTIFICATION AND ANTIMICROBIAL POTENTIAL.

A. Ismail-Ben Ali [1], L. Ktari [1]*, H. Bolhuis [2], A. Boudabbous [3], L. J Stal [2] and M. El Bour [1]

[1] Laboratory of marine organisms pathology, National Institute of Marine Sciences and Technologies - leila.ktari@instm.rnrt.tn

[2] Department of Marine Microbiology, Netherlands Institute of Ecology, NIOO-KNAW, P.O. Box 140, 4400 AC Yerseke, The Netherlands.

[3] Faculty of Mathematical, Physical and Natural Sciences of Tunis

Abstract

Seventeen marine bacteria associated with the green alga *Ulva intestinalis* (northern coast in Tunisia), were isolated and tested for antibacterial and antifungal activity. None of the 17 isolates displayed antifungal activity whereas two isolates displayed antibacterial activity with different antibiotic spectra. These two isolates (U1 and U5) belonged to Alpha-proteobacterial genus *Stappia*. Strain, U5, showed the strongest activity against pathogens especially *Staphylococcus aureus* and *Aeromonas salmonicida*. Algae like *U. intestinalis* may benefit from epiphytic bacteria such as *Stappia* as potential resources of natural antibiotic production and concomitant protection against undesirable prokaryotes.

Keywords: Algae, Bacteria, Biodiversity, Antibiotics

Introduction

Bacteria surviving on marine algae live in highly competitive, nutrient limited environment. This competition for both space and nutrient inflict selective pressure on the marine microorganisms that may result in the production of bioactive compounds of possible medical and biotechnological value [1]. In Tunisian coast, the green alga *U. intestinalis* is abundantly present but little is known about their epibionts and the ability of these to produce bioactive compounds. Here we investigate the culturable bacterial fraction, colonizing *U. intestinalis* and focus on their antimicrobial activity against pathogens bacteria and yeast.

Materials and methods

Marine green algae *U. intestinalis* were collected from coastal waters, north of Tunisia in Cap Zebib (37° 16.2' N, 10° 3.6' E) between January and November 2007. Seaweed samples were washed and epiphytic bacteria were isolated [2, 3]. Identification of isolates was realized by PCR amplification of 16S rRNA gene. In vitro antibacterial tests were performed against fifteen sensitive bacteria including fish and human pathogens (*Aeromonas hydrophila , Pseudomonas cepacia, Vibrio anguillarum, Vibrio tapetis* CECT 4600, *Aeromonas salmonicida, Salmonella typhymurium, Streptococcus sp., Staphylococcus aureus, Vibrio alginoliticus, E. coli* O126B16, *E. coli* ATCC 25922, *Pseudomonas fluorescens* AH2, *Pseudomonas aeruginosa* ATCC 27853, *Staphylococcus aureus* ATCC 25923, *Enterococcus feacalis* ATCC 29212) and *Candida albicans* ATCC.

For the bioassay, drops of 10µl of the algae-associated bacteria suspension were spotted on the agar plates swabbed with the test strains and allowed to dry at room temperature. After incubation for 24 h, antibacterial activity was evaluated by measuring the inhibition zone (in mm) from the edge of the colony to the edge of the clear zone.

Results and discussion

Seventeen morphological distinct isolates were selected from *U. intestinalis* surface and tested for potential antibacterial and antifungal activities. Ten isolates were identified by PCR amplification and 16sRNA gene sequencing. Among them, nine were gram-negative, assigned to *Proteobacteria* (Gamma (one strain) and Alpha subclasses (seven strains)) and *Bacteroidetes* (one strain). Only one strain was gram-positive. *Gamma-Proteobacteria* subclass was represented by the genus *Vibrio*. This isolate appears to be not closely associated to its host since it was found inhibited by *U. intestinalis* extracts (unpublished data). Only two strains U1 and U5 showed antibacterial activities. These isolates were closely related to *Stappia* sp. Strong activity was detected for U5 against gram-positive pathogens:*S. aureus and S. aureus* ATCC 25923 and gram-negative *A. salmonicida* (Table 1). Similar antimicrobial activity of epiphytic seaweed bacteria was reported previously [3]. These authors described *U. intestinalis* as the main source of antibiotic producing bacteria that were identified as *Pseudomonas-Alteromonas.* Here we isolated *antibiotic producing* strains of *Stappia* sp. from *U. Intestinalis*, a promising result in the discovery of novel antibacterial compounds. Further analyses and characterization of the antibacterial compound is in progress.

Table.1. Antibacterial spectra of the *U. intestinalis* active strains U1 and U5.

	Active strains	
Test strains	**U1**	**U5**
***S.aureus* ATCC 25923**	**-**	**13**
S.aureus	**-**	**13**
A.salmonicida	**4**	**12**
Streptococcus.sp	**3**	**-**
P.auruginosa	**4**	**-**
A. hydrophila	**4**	**-**

Zone of inhibition (mm) measured considering the spot diameter, -: No activity.

References

1 - Armstrong E., Yan L., Boyd K.G., Wright P.C. and Burgess J.G., 2001. The symbiotic role of marine microbes on living surfaces. *Hydrobiologia.*, 461: 37-40.

2 - Burgess J.G., Boyd K.G., Armstrong E., Jiang Z., Yan L., Berggren M., May U., Pisacane T., Granmo A. and Adams R.D., 2003. The Development of a Marine Natural Product-based Antifouling Paint. *Biofouling*., 19:197–205.

3 - Lemos M.L., Toranzo A.E. and Barja J.L., 1985. Antibiotic activity of epiphytic bacteria isolated from intertidal seaweeds. *Microb. Ecol*., 11: 149-163.

EVALUATION OF PESTICIDES TOXICITY USING BIOSENSORS OF THE MARINE PHOTOSYNTHETIC PICOEUKARYOTE *OSTREOCOCCUS TAURI*

Fabien Joux [1]*, Fanny Leroy [1], Sophie Sanchez [1] and François-Yves Bouget [1]
[1] Laboratoire d'Océanographie Microbienne, CNRS, Université Paris6, Observatoire Océanologique - joux@obs-banyuls.fr

Abstract
Biosensors expressing the firely luciferase driven by specific genes were developed in the marine photosynthetic picoeukaryote *Ostreococcus tauri* and used to measure the toxicity of different pesticides (diuron and its metabolites DCPU and DCPMU, irgarol 1051, glyphosate, chlorpyrifos). Results were compared to the conventional assay of growth inhibition. Our results demonstrate that the use of luminescent biosensors can constitute a sensitive, high-throughput and non-invasive approach to assess the toxicity of pesticides. The gene encoding the cycling-dependent-kinase A (*CDKA*) implicated in cell cycle appeared to be the most sensitive to the pesticides tested.
Keywords: Ecotoxicology, Phytoplankton, Pesticides, Biotechnologies, Physiology

Introduction - Coastal ecosystems are exposed to various pollutants including pesticides. These pesticides can come from agricultural activities or from the leaching of biocides used as marine antifouling agents. These different pesticides may affect non-target organism including phytoplankton. There is a great interest to develop new approaches to detect the toxicity of theses pollutants for marine organisms and to perform ecotoxicological tests considering the interactions between different pollutants or the interactions of pollutants with environmental parameters. To resolve this complexity a high-throughput and sensitive assay is required. We propose here the use of the marine photosynthetic picoeukaryote *Ostreococcus tauri* for which biosensors expressing the luciferase under specific gene control have been developed [3]. *O. tauri* belongs to the *Prasinophyceae* and is reported as a globally abundant in Mediterranean coastal lagoons and in the oceans [1,2]. The most striking feature of *O. tauri* is it minimal cellular organization (a naked, 1-micron cell, lacking flagella, with a single chloroplast and mitochondrion), and a small genome (12.56 Mb) completely sequenced [4]. This is the first eukaryotic algal model where stably transformed luciferase lines accurately report gene expression [3].

Material and methods - For the growth inhibition assays, *O. tauri* strain 0TTH0595 was grown in 96-wells microplate at 25°C with Keller media under constant illumination at 56 µmole.quanta. $cm^{-2.}$ sec^{-1}. Cells were introduced at 5 x 10^6 cell/ml and the pesticides were added 24 h after inoculation. Growth of cultures was measured by flow cytometry (Cell Lab Quanta^{TM} MPL, Beckman Coulter) over 72 h. For the luminescence assays, four different transformed luciferase lines were used in this study (Table 1). The different modified genetic lines were grown in 96-wells white microplate at 20°C with Keller media and luciferin (10 µM) under constant illumination at 13 µmole.quanta. $cm^{-2.}$ sec^{-1}. Cells were introduced at 10 x 10^6 cell/ml and the pesticides were added 24 h after inoculation. Luminescence was acquired every 2 h (Berthold LB Centro automated luminometer) and over 72 h to follow *in vivo* expression of genes of interest.

Results and discussion - Based on the growth inhibition assays it was possible to classify the toxicity of the pesticides as follow: irgarol > diuron > DCPU > DCPMU > glyphosate > chlorpyrifos. The use of luminescent biosensors gave the same order of toxicity but the effective concentration of each pesticide leading to a decrease of 50% of luminescence was most of the time lower than the concentration leading to 50% of growth inhibition, suggesting a more sensitive assay. Moreover, the automated, non-invasive and highly reproducible measurements of luminescence give additional advantages to the use of the biosensors compared to the growth inhibitions assays, promoting this new assay as a method of choice to monitor pesticide toxicity in the marine environment. When the different biosensors were compared we observed that pesticides tested had a stronger inhibitory effect on the expression of cell cycle-regulated genes (*CyclineA* and *CDKA*) compared to the photosynthesis (*CAB*) and the circadian clock (*TOC1*) regulated genes. The *CDKA:Luc* reporter gene was the most promosing biosensor since it had high basal level of luminescence and yielded highly reproducible results. The results are very promising for the design of a fast and automated ecotoxicological test based on *O. tauri* luminescent biosensors, which could constitute a useful tool for studying i) the impact of environmental parameters influencing the sensitivity of microorganisms to toxic compounds and ii) the interactive effects of different pollutants.

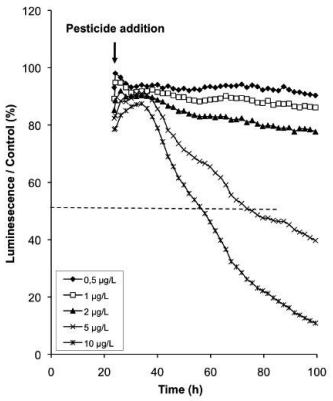


Fig. 1. Effect of different concentrations of diuron on the gene expression of *CDKA* in *O. tauri* as measured with the luminescent biosensor. The luminescence data are expressed in percentages relative to control cultures and are the mean of three independent wells. The dashed line indicate 50% of inhibition of *CDKA* gene expression

Tab. 1. The different luminescent biosensors used

Gene	Function	Luciferase gene reporter system
Chlorophyll a Binding protein *(CAB)*	Photosynthesis	Transcriptional fusion
Cycline Dependant Kinase A *(CDKA)*	Cell cycle	Translational fusion
CyclineA	Cell cycle	Translational fusion
Timing Of *CAB* expression *(TOC1)*	Circadian clock	Translational fusion

Acknowledgements. This study was funded by the CNRS-EC2CO program (DIGAMÉ project).

References
1 - Courties C., et al., 1994. Smallest eukaryotic organism. *Nature* 370: 255.
2 - Worden A.Z., et al., 2004. Assessing the dynamics and ecology of marine picophytoplankton: The importance of the eukaryotic component. *Limnol. Oceanogr.* 49: 168-179.
3 - Corellou F., et al., 2009. Novel clocks in the green lineage: Comparative functional analysis of the circadian architecture in the picoeukaryote *Ostreococcus. Plant. Cell* (in press).
4 - Derelle E., et al., 2006. Genome Analysis of the smallest free-living eukaryote *Ostreococcus tauri* unveils unique genome heterogeneity. *Proc. Nat. Acad. Sci. USA* 103: 11647-11652.

VIRIOPLANKTON DISTRIBUTION RELATED TO BACTERIAL METABOLIC STATUS DURING AN AUTUMN SURVEY IN THE NORTHERN ADRIATIC SEA

Ana Karuza [1], Erica Crevatin [1] and Paola Delnegro [1]*

[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Department of Biological Oceanography - pdelnegro@ogs.trieste.it

Abstract

The study was performed during November 2004 in order to detect spatial distribution of marine viruses in the surface waters of the Northern Adriatic Sea, to assess their interaction with bacteria as their most common host, and to investigate the influence of bacterial metabolic status on viral proliferation. Our results confirmed the numerical prevalence of viral fraction within the microbial community and showed that not only the highly active but also less active or dormant bacterial cells can sustain viral proliferation, the latter resulting particularly intense at the mouth of the River Po.

Keywords: Adriatic Sea, Bacteria, Coastal Waters, Po Delta

The importance of viral infection for overall bacterioplankton mortality tends to increase with increasing bacterial abundance and/or productivity [1] with the evidence that more active bacterial cells may be more susceptible to viral infection and that a more active bacterial community may sustain higher viral abundance [2]. Since the detection of highly active cells by using CTC method [3], only partially explains the activity of bacterial community the discrimination of non-viable (dead) bacteria could further help in understanding viruses-bacteria interactions. The marked trophic gradient of water masses in the Northern Adriatic represented suitable study area for investigating differences in microbial interactions. Surface water samples were collected from 18th to 21th November 2004 along 5 transects for a total of 25 stations (Fig. 1).

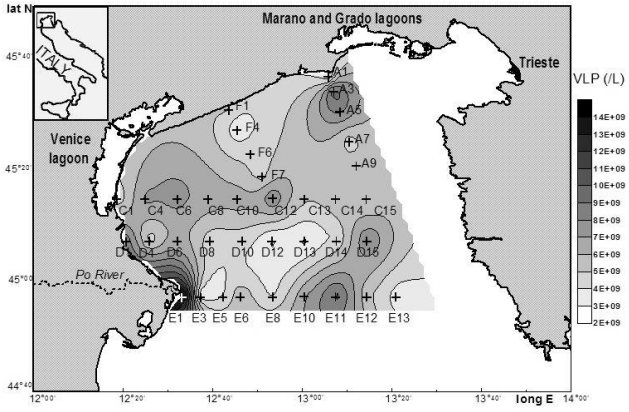


Fig. 1. Sampling stations in the Northern Adriatic Sea. Contour map indicates distribution of virioplankton abundances

Temperature, salinity, oxygen saturation and fluorescence data were obtained using CTD multiparametric probe (Idronaut Ocean Seven 316). Samples for biological analyses were collected using a Carousel water sampler carrying Niskin bottles. Viral abundance was determined using SYBR Green I protocol [4]. Total bacterial abundance was determined using DAPI staining method [5] while non vital cells were distinguished using PI nucleic acid stain and processed according the manufacturer (Molecular Probes). Metabolically active bacteria were detected by CTC incubation technique [6]. Bacterial Carbon Production (BCP) was determined by [^{3}H]-Leucine incorporation [7] only along C and E transects (for a total of 9 stations). Seawater temperature ranged from 11.3 to 16.6°C. Minima values were found in the coastal area, increasing towards the central part of the basin. Salinity ranged between 29.7 and 38.4 with rather opposite pattern to the seawater temperature ($p<0.01$). Dissolved oxygen, ranging between 82-93%, also resulted significantly but positively correlated with temperature ($p<0.05$). These suggested the presence of a large amount of freshwater in the coastal belt, which matched with the highest fluorescence values. In the entire area fluorescence remained low ranging between 0.1 and 0.8 µg Chl*a* l^{-1}. Virioplankton abundances (Fig. 1) ranged between 3.8 and 19.9×10^9 l^{-1}. Higher values were found near the Po River mouth (coastal stations of the E transect) and offshore the lagoons (A3 and A5 stations). Bacterioplankton displayed quite narrow variability, ranging within 0.9 and 1.8×10^9 cells l^{-1}. The abundance of highly active bacteria varied from 1.4 to 5.9×10^7 l^{-1}, thus remaining below 5% of total bacterial abundance. A clear coast to offshore decreasing gradient was observed with the highest CTC+ abundance and the maximum VBR ratio of 14 near the Po River mouth. In that area also bacterial production rate was the most intense (0.485 µg C l^{-1} h^{-1}), gradually decreasing along the C transect, whether the minimum rate of 0.026 µg C l^{-1} h^{-1} was found in the offshore stations of the E transect. Non vital bacteria ranged between 0.1 and 9.5×10^8 l^{-1} and their proportion within total bacterial community strongly varied from 0.4% up to 91%. It was found quite similar but opposite distribution pattern of virioplankton and non vital cells ($p<0.08$). Our results evidenced wide spatial variability of virioplankton and confirmed its numerical prevalence within the microbial plankton community of the N Adriatic surface waters. It is plausible that the riverine inflow increasing the trophic status of the system largely influenced viral distribution and the intensity of virus-bacteria interaction. Contrary to the results reported for the entire Adriatic [2], we found that virus-bacteria interaction can not be explained by the distribution of total bacterial community itself. Viral distribution matched quite well with bacterial production and the abundance of active bacteria, but only in the area proximal to the Po River mouth, suggesting that bacteria in this area shifted their metabolism to highly active status. The possibility of the copious enrichment in viral abundances from outside sources was also considered, but was less plausible since viruses in the sea are generally from within the system [8]. The large proportion of non vital cells was found also by other authors [9], even if they put under discussion the reliability of the PI method to indicate non active or dead bacteria. The relationship between viruses and active, non vital and total bacterial community suggests that viral proliferation is not only due to the highly active but also dormant bacterial host while the infection of non vital bacterial cells is not productive, thus further confirming the key role of bacterial activity in controlling viral dynamics.

References

1 - Noble R.T. and Fuhrman J.A., 2000. Rapid viral production and removal as measured with fluorescently labeled viruses as tracers. *Appl. Environ. Microbiol.*, 66: 3790-3797.

2 - Corinaldesi C., Crevatin E., Del Negro P., Marini M., Russo A., Fonda Umani S., Danovaro R., 2003. Large-scale spatial distribution of virioplankton in the Adriatic sea: testing the trophic state control hypothesis. *Appl. Environ. Microbiol.*, 69: 2664-2673.

3 - Karuza A., Del Negro P., Paoli A., Comisso S., Fonda Umani S., 2004. Highly active bacteria in the surface waters of the Gulf of Trieste (Northern Adriatic Sea). *Rapp. Comm. int. Mer Médit.*, 37: 277.

4 - Noble R.T and Fuhrman J.A., 1998. Use of SYBR Green I for rapid epifluorescence counts of marine viruses and bacteria. *Aquat. Microb. Ecol.*, 14: 113-118.

5 - Porter K.G. and Feig Y.S., 1980. The use of DAPI for identifying and counting aquatic microflora. *Limnol. Oceanogr.*, 25: 943-948.

6 - Paoli A., Karuza A., De Vittor C., Del Negro P., Fonda Umani S., 2006. Daily variations of highly active bacteria in the Northern Adriatic Sea. *J. Plankton Res.*, 28(3): 325-335.

7 - Smith D.C., Azam F., 1992. A simple, economical method for measuring bacterial protein synthesis rates in sea water using ^{3}H-leucine. *Mar. Microb. Food Webs*, 6: 107-114.

8 - Wilhelm S.W. and Suttle C.A., 1999. Viruses and nutrient cycles in the sea. *Bioscience* 49, (10): 781-788.

9 - Pirker H., Pausz C., Stoderegger K.E., Herndl G.J., 2003. Simultaneous measurement of metabolic activity and membrane integrity in marine bacterioplankton determined by confocal laser-scanning microscopy. *Aquat. Microb. Ecol.*, 39: 225-233.

EVALUATION DE LA QUALITE BACTERIOLOGIQUE DE LA FRANGE COTIERE DE TETOUAN «KABILA - OUED LAOU»

Soumaya Khannous [1]*, Hassan Er-Raioui [1] and Rachid Boutaib [2]
[1] Faculté de Sciences et Techniques de Tanger, 90000, Maroc - khsoumaya@yahoo.fr
[2] INRH Centre Regional d'Oceanographie, Tanger, 90000, Maroc

Abstract
Parallèlement au développement industriel et urbain, la contamination du milieu littoral par des produits organiques et chimiques générés par les activités humaines est devenue un fléau préoccupant. Ce travail présente une caractérisation bactériologique portant sur l'appréciation de la contamination globale et de la contamination fécale. Les résultats révèlent une bonne qualité microbiologique des eaux du littoral étudiées, avec une variation saisonnière de la charge bactérienne, présente à un niveau important durant les périodes pluvieuses.
Keywords: Bacteria, Coastal Waters

Introduction
Le littoral méditerranéen présente quelques zones de forte densité de population, particulièrement entre Tanger et Tétouan, ce qui entraîne un développement du tissu industriel dans cette région. Ce développement a un impact négatif sur l'environnement naturel et le milieu marin en particulier. Des études antérieures [1] montrent que les eaux de la zone littorale méditerranéenne comprise entre Fnideq et Kaâ-srass, indiquent une bonne qualité microbiologique, excepté pendant la période des pluies où de légers dépassements du seuil de la salubrité sont observés au niveau de Kabila, Martil et Oued Laou. Afin de caractériser la qualité microbiologique de l'eau de mer de la frange côtière de Tétouan, allant de Kabila à Oued Laou, une analyse dénombrant la flore mésophile aérobie totale, les coliformes fécaux et totaux et les entérocoques fécaux perfringens a été mise en place.

Matériel et méthodes
Les analyses bactériologiques permettent de dénombrer la flore mésophile aérobie totale (FMAT), les coliformes totaux (CT) et fécaux (CT) et les streptocoques fécaux (SF) après filtration sur membrane (45µm). La gélose PCA a été utilisée comme milieu de culture pour la FMAT, la gélose VRBA pour CT et CF et le milieu de Slanetz et Barthely pour SF.

Résultats et discussion
Les résultats obtenus montrent que la charge bactrienne moyenne de cet écosystème pélagique est de 2,89 10^2 UCF/100ml. La station de l'embouchure de l'oued Laou semble être la plus contaminée avec 1,04.10^3 UCF/100ml. Les précipitations enregistrées dans la région durant la période d'échantillonnage sont importantes pendant toute l'année excepté durant l'été. Des pics maximums sont observés en automne et au printemps . Ce profil de variation est semblable à celui de la charge bactérienne enregistrée durant la même période sur les mêmes sites. Ce travail suggère une relation étroite entre la quantité de charge bactérienne et les précipitations. Il semble que la pluviométrie et les crues jouent un rôle déterminant dans les processus de contamination correspondant également à l'importance de la charge polluante.

Conclusion
Cette étude révèle que le site le plus exposé à la contamination bactérienne est l'embouchure de l'oued Laou et suggère une relation étroite entre la pluviométrie et la charge bactérienne sur tous les sites examinés. Cela se produit parallèlement à une augmentation de la charge polluante.

References
1 - Bernoussi A., 1996. Études de la qualité bactériologique des principales zones conchylicoles du littoral marocain de 1993-1995. Travaux et Documents no 91 – INRH.

STUDY OF PHYTOPLANKTON ABUNDANCE AND DIVERSITY IN THE SOLAR SALTERN OF SFAX (TUNISIA)

H. Khemakhem [1]*, J. Elloumi [1], W. Guermazi [1], M. Moussa [2], L. Aleya [3] and H. Ayadi [1]
[1] Université de Sfax, Faculté des Sciences de Sfax, Département des Sciences de la Vie. Unité de recherche UR/05ES05 Biodiversité et Ecosystèmes Aquatiques, - hajer.khemakhem@yahoo.fr
[2] Laboratoire d'Hydraulique, Ecole Nationale d'Ingénieurs de Tunis
[3] Université de Franche-Comté, Laboratoire de Chrono-Environnement, UMR CNRS 6249

Abstract
The solar saltern of Sfax sustained an abundant phytoplankton community with higher diversity in the outer than the inner zone in terms of Shannon-Weaver diversity index (H'). Some environmental parameters such as salinity seem to play an important role in determining the phytoplankton community succession and then diversity, favoring or limiting the growth of the different phytoplankton groups.
Keywords: Phytoplankton, Salinity, Biodiversity

Introduction
Several investigations on plankton were conducted in the solar saltern of Sfax [1, 2, 3]. In this ecosystem, phytoplankton was found to tolerate different salinity [1]. That's why, they could be found in the five ponds of our study, but most of them concentrated in the pond of low salinity [3]. In this study, phytoplankton density was described in 2000 and 2003 in five ponds of increasing salinities.

Material and methods
2-1- Sampling
Sampling was carried out in the central part of the five ponds A1, A16, C2-1, M2 and TS in 2000 and 2003.
2-2- Phytoplankton
Water samples (200 ml) were fixed by Lugol's iodine solution and counted under an inverted microscope (× 400) using the Utermöhl method. Phytoplankton identification was made from morphological criteria after consulting various keys.
2-3- Statistical analysis
Mean and standard deviation (SD) were reported when appropriate. The potential relationships between variables were tested by Pearson's correlation coefficient.

Results and discussions
The density of total phytoplankton community marked differences between ponds and years. Phytoplankton density ranged between $0.44 \times 10^6 \pm 0.62 \times 10^6$ cells l^{-1} (pond A1) and $1.23 \times 10^6 \pm 1.87 \times 10^6$ cells l^{-1} (pond M2) during the year 2000 (Table 1).

Tab. 1. Annual Mean ± SD of total phytoplankton density, diversity index and salinity in ponds A1, A16, C21, M2 and TS during the years 2000 and 2003.

Ponds	Years	Total phytoplankton (×10⁶ cells. l⁻¹)	Diversity index (bits. cells⁻¹)	Salinity (p.s.u)
A1	2000	0.44 ± 0.62	1.68	42.6 ± 2.3
	2003	0.64 ± 0.82	1.26	45.2 ± 5.3
A16	2000	0.55 ± 0.91	1.36	74.8 ± 3.0
	2003	0.41 ± 0.28	1.0	78.9 ± 8.2
C21	2000	0.96 ± 1.09	1.19	84.7 ± 5.1
	2003	0.6 ± 0.71	1.14	90.2 ± 11.2
M2	2000	1.23 ± 1.87	1.17	171.9 ± 11.0
	2003	3.34 ± 4.38	1.09	190.1 ± 12.9
TS	2000	0.73 ± 1.05	0.23	393.3 ± 38.4
	2003	1.39 ± 1.39	0.36	423.8 ± 33.1

Throughout the year 2003, phytoplankton density increased in all the ponds. The most important phytoplankton density was recorded in pond M2, at about $3.34 \times 10^6 \pm 4.38 \times 10^6$ cells l^{-1} (Table 1).
The density of total phytoplankton decreased in pond TS. The highest density recorded in pond M2 was due to the high abundance of *Dunaliella salina* (66%) recorded in 2000, and the coexistence of *Dunaliella salina* (51%) and *Chlamydomonas rublifilum* (49%) throughout 2003. The density of the species controlled by salinity was a density-controlling factor [1,2]. Several studies confirmed this result [1,2,3,4]. In consistency with this finding, Elloumi et al. [2]reported that *D. salina* was the major phytoplankton taxon in the Sfax saltern. The majority of these studies mentioned the decrease of aquatic communities' densities with the salinity gradient. The diversity index decreased with the increasing of salinity. This can be explained by the negative correlation recorded between salinity and diversity index ($r = -0.96$; $n = 3$; $p < 0.05$), ($r = -0.94$; $n = 3$; $p < 0.05$) in 2000 and 2003 respectively.

References
1 - Ayadi H., Abid O., Elloumi J., Bouaïn A. and Sime-Ngando T., 2004. Structure of the phytoplankton in two lagoons of different salinity in the Sfax saltern (Tunisia). *J. Plankton Res.*, 26: 669-679.
2 - Elloumi J., Carrias J.F., Ayadi H., Sime-Ngando T., Boukhris M. and Bouaïn A., 2006. Composition and distribution of planktonic ciliates from ponds of different salinity in the solar saltwork of Sfax, Tunisia. *Estuar. Coast. Shelf Sci.*, 67: 21-29.
3 - Abid O., Sellami-Kammoun A., Ayadi H., Drira Z., Bouaïn A. and Aleya L., 2008. Biochemical adaptation of phytoplankton to salinity and nutrient gradients in a coastal solar saltern, *Tunisia. Estuar. Coast. Shelf Sci.*, 80: 391-400.
4 - Williams W.D., 1998. Salinity as a determinant of the structure of biological communities in salt lakes. *Hydrobiologia*, 381: 191-201.

FROM PURE CULTURES TO BACTERIAL COMMUNITIES: KNOWLEDGE GENERATION BY EXPRESSION PROFILING

C. Klockow [1]*, A. Klindworth [1], B. Öztürk [1], P. Wecker [2] and F. O. Glöckner [1]
[1] Max Planck Institute for Marine Microbiology, Germany & Jacobs University Bremen, Germany - cklockow@mpi-bremen.de
[2] Max Planck Institute for Marine Microbiology

Abstract
The majority of prokaryotes live in marine habitats and play a key role in global element cycling. Yet, most of them are still unexplored and little is known about their functions as well as their reactions to the rapidly changing environment. Plus, they are expected to be a treasure trove for new genes interesting for biotechnology and medical applications. Transcriptomics and Metatranscriptomics are currently the techniques of choice to assess gene expression and to unravel the reactions of the microbes to environmental changes. In this study we present gene expression studies for the marine model bacterium *Rhodopirellula baltica* SH1^T and metatranscriptome studies employing 'Next Generation Sequencing' to analyze seasonal changes in the North Sea.
Keywords: Bacteria, Genetics, Time Series, Monitoring, Surface Waters

The complete genome sequencing of the marine planctomycete *Rhodopirellula baltica* SH1^T revealed many fascinating and rare features like a high number of sulphatases and a global mechanism of gene regulation. In order to gain further knowledge about this intriguing organism, it was cultured under various conditions in chemostats and the resulting gene expression was analyzed with whole genome microarrays. The presented data (Fig. 1) illustrates the reaction of the organism to heat, cold and salinity shocks. Separately for each condition, the gene regulation was monitored during time series, with sampling after 10, 20, 40, 60 and 300 min. The response to heat shock was most pronounced after 40 min, while adaptation to salinity up-shift took 300 min. The strongest overall response was observed in the heat shock experiment. During cold shock, the cells seem to reduce their activity. Hence, the number of upregulated genes is significantly smaller than the number of downregulated ones.

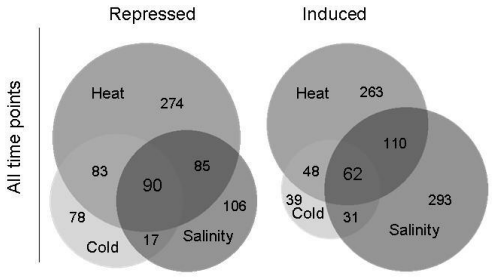


Fig. 1. Stress answer of R. baltica with the number of regulated genes

R. baltica shows a general stress response as well as a specific answer to different stress situations. While heat shock mainly influenced the classical heat shock genes, cold shock also had an impact on genes from the lipid metabolism. In addition, genes involved in recombination, in secondary metabolites biosynthesis, transport and catabolism were induced at enhanced temperature. Interesting was also the upregulation of SecA, which belongs to the extracytoplasmic stress response. In the cold shock experiment, genes for amino acid biosynthesis as well as for protein fate and synthesis were down-regulated, emphasizing the switch to a passive state of the cells. Genes involved in sporulation (oppB) and pilus assembly were repressed, leading to reduced motility and budding ability. The salinity shift changed the expression of genes, which encode for enzymes with a function in ion transport and in morphology. Glutamate and trehalose act as cytoplasmic osmoprotectants, which is why the respective genes involved in the synthesis of these components were upregulated due to the osmotic shock.
The experiment also enabled us to predict new functions to a set of genes without an assigned function by analyzing coregulations with known genes.This will not only enrich the functional information in the databases but might also lead to the discovery of new enzymes for biotechnology or medical applications.

Open questions : Can knowledge gained by pure culture experiments be transferred to natural habitats? Do microorganisms behave similar in the environment and in the lab and how do the over 90% of uncultivable species react to environmental changes?

To answer these questions, the MIMAS "**M**icrobial **I**nteractions in **MA**rine **S**ystems" project was set up. It aims at investigating the seasonal changes in the microbial communities at two long term ecological research sites in the North Sea (Helgoland Roads) and the Baltic Sea (Gotland Deep). The Gotland Deep is known for its stable waterbody and an Oxic-Anoxic intersection at a depth of 120 m. In contrast, Helgoland Roads captivates with its fast exchanging waterbody. In order to explore the biodiversity of the Helgoland Roads research site, single cell *in situ* hybridization and ribosomal RNA sequencing are performed. However, the core of the project is based on a "Meta-Omics" approach: Metatranscriptomics and Metaproteomics will shed light into the active fraction of genes, while Metagenomics will address the genetic potential of the bacterial community as a whole. This integrated approach will give new insights in the ecological role of marine bacterial communities and their response to environmental changes such as climate change.
Metatranscriptome analysis (Fig. 2) will be performed via pyrosequencing to get a comprehensive insight into the flexible gene expression adaptation of the bacterial community due to seasonal changes of their environment. For this purpose seawater is sampled by serial filtration, total RNA is isolated and the rRNA removed. Subsequently, ds cDNA is synthesized from mRNA using random hexamers. The following cDNA sequencing is performed with a GS FLX Titanium Pyrosequencer. Finally, Metatranscriptomic data are analyzed in relation to environmental parameters using a novel data analyzing pipeline invented and developed in house.

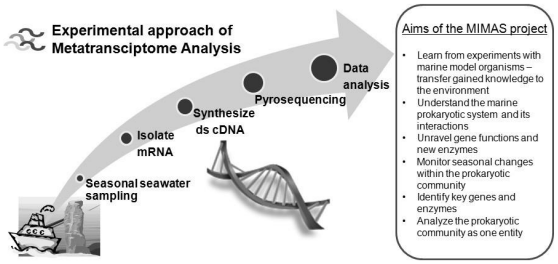


Fig. 2. Experimental approach of the Metatranscriptomic part in the MIMAS project

We thank the Max Planck Society and BMBF (contract number 03F0480D) for funding and Jens Harder and Matthias Gottschalk, Microbiology, MPI Bremen, for the chemostat cultivations.

References
1 - Glöckner FO, Kube M, Bauer M, Teeling H, Lombardot T, Ludwig W, *et al*., 2003. Complete genome sequence of the marine planctomycete *Pirellula* sp. strain 1. *Proc Natl Acad Sci USA*100: 8298-8303.
2 - Wecker P, Klockow C, Ellrott A, Quast C, Langhammer P, Harder J, GlöcknerFO., 2009. Transcriptional response of the model planctomycete *Rhodopirellula baltica* SH1^T to changing environmental conditions, BMC Genomics.

RESEARCH OF SERUM AMYLOID A AND TRANSFERRIN LEVELS FOLLOWED AFTER *STREPTOCOCCUS INIAE*- INFECTED IN TILAPIA (*OREOCHROMIS NILOTICUS*)

Azime Küçükgül Güleç [1]*
[1] University of Tunceli Fishing Faculty/TURKEY - azimekucukgul@yahoo.com

Abstract
Streptococcus iniae is an important bacterial pathogen of fish, causing up to 50% mortality in stocks, which has recently been associated with human infections. Some disease states are associated with, or are causally related to acute phase proteins (APPs). Acute phase responses (APRs) to *S. iniae* (ATCC 29178) were characterized in plasma of tilapia following intraperitoneal (i.p.) infection. Two experimental groups, including *S.iniae*-infected and *S.iniae*-infected+handling stress, with a group of nonstressed control fish, were examined. Samples for plasma analysis were utilized to analyze serum amyloid A (SAA) and transferrin (Tf). The diseases signs observed in tilapia were erratic, slowdown in fish motions and darkened skin. SAA and Tf has been reported to decrease in acute phase plasma.
Keywords: Bacteria, Diseases, Fish Behaviour

Introduction
Streptococcus spp. have been recently listed among the emerging problems in aquaculture. Fish farms in many parts of the world have suffered serious economic losses due to this bacterial pathogen. For fish populations, many parameters (factors) have been measured as biomarkers. APPs that is one of them are plasma or serum proteins whose levels change in response to tissue damage, infection, or inflammation (Gaby and Kushner, 1999). APPs are an established diagnostic tool as early indicators of inflammation and disease Recently, studies have showed significant diagnostic informations in prognose and fixing of diseases of APPs consantration levels in plasma [2].

Materials ve Methods
Tilapia (mean 60 g) were acclimated in the experimental ponds for 1 month prior to experiments. The fish were fed with carp feed at 2–3% body weight daily. For each treatment, there were triplicates and each pond was stocked with 5 fish (72 fish in total). Tilapias were injected intraperitoneally (i.p.) of *S. iniae* (ATCC–29178) obtained from Deutsche Samlung Von Microorganismen Zellkulturna Gmbh (DSMZ). In first group, tilapias were susceptible to $3.3x10^5$ (sublethal dose) S. iniae colony forming units (CFU). The second group were exposed to both *S. iniae*-infection and handling stress for 15 minutes additionally. The last group was the control group. The fish were sampled on the 0, 7th, 14th and 21st day after the end of the challenge trial. Samples for plasma analysis were collected from caudal venepuncture of infected fish. Serum SAA was measured using the N-high sensitivity CRP assay with latex-enhanced immunonephelometricy assay on a BN II analyzer (Dade Behering, Milan, Italy). Transferrin were analyzed by Roche/Hitachi 902 machine used immunoturbiditometric immune assay with Randox (Kat. no: TF 7197). T-test (Independent samples) and Mann-Whitney test and Student's t were used for statistic analyses.

Results and Discussion
Macroscobic diagnosis obtained darkening of the skin, untidiness in fish motions and slowing down, immobility in pool edges were the first signs observed in tilapia. In microscobic datas, haemorrhages were observed on the ventral side of the body, lesions and hyperemiae in skin. Dermal hemorrhages on the body surface and around the mouth, opercles, base of fins and anus [3] have been observed in *S. iniae* infected moribund tilapia. These observations are often assumed to be identical to those that occur from *S. iniae* infections. While SAA levels increased in the first and second week, it decreased at the last of the third week. In constrat to SAA, a contrary situation was followed in transferrin levels of the same weeks. Jensen et al (1997) were examined changes in APPs in salmonids. In this study, fish were injected with live *A. Salmonicida*. Increases in SAA levels has been determined. Transferin levels, for both group of the first week, were occured decreased but following weeks its level reached to control levels. Determination of APPs can help in monitoring health of individual subjects.

References
1 - Nelson D.M., Treguer P., Brzezinski M.A, Leynaert A., Queguiner B., 1995. Production and dissolution of biogenic silica in ocean: revised global estimates, comparison with regional data and relationship to biogenic sedimentation, *Glob. Biogeochem.*, Cycles 9:359–372.
2 - Guillard, R.R.L and Rhther J.H., 1962. Studies on marine planktonic diatoms I. *Cyclotella nana* Hustedt and *Detomula Confervacae* (Cleve). Gran. Can. *J. Microbiol*., 8:229-239.
3 - Smayda, T.J., 1997. Harmful blooms: Their ecophysiology and general relevance to phytoplankton blooms in the sea. *Limnon. Oceanogr*., Vol. 425 pp.1137-1153.
4 - Thomas, W. H., Dodson A. N., 1972. On Nitrogen Defficiency in Tropical Pacific Oceanic Phytoplankton. II. Photosynthetic and Cellular Characteristics of a Chemostat-Grown Diatom.

GROWTH KINETICS OF TWO DIATOMS *SKELETONEMA COSTATUM* AND *THALASSIOSIRA SP.* FROM IZMIR BAY (EASTERN AEGEAN SEA /TURKEY).

S. Kukrer [1], F. S. Sunlu [1]*, B. Buyukisik [1], H. Aydin [2] and U. Sunlu [1]
[1] Ege University Faculty of Fisheries Dept. of Hydrobiology - f.sanem.sunlu@ege.edu.tr
[2] Celal Bayar University, Fac. of Arts And Sciences, Muradiye, Manisa, Turkey

Abstract

The purpose of this research is to reveal the detailed information on growth kinetics of *Skeletonema costatum* and *Thalassiosira sp.* sampled from Izmir Bay. From the results of enrichment experiments under batch culture conditions it has been found out the limiting nutrinet for *Skeletonema costatum*is nitrate and for *Thalassiosira sp.* isreactive phosphate (RP).

Keywords: Aegean Sea, Phytoplankton, Nutrients, Growth, Eutrophication

Introduction

Primary production impetus is depending on the presence of nutrients in water column and their uptake rate by phytoplankton. The most important sources of nutrient enrichment in coastal waters are atmospheric deposition, enrichments from bottom waters and rivers as a point sources. Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth (algae, periphyton attached algae, and nuisance plants weeds). This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and can cause other organisms to die. The understanding and preventing of europhication are depending on knowing the relationship between nutrients and phytoplankton.With the batch culture experiments carried out using the diatoms *Skeletonema costatum*and *Thalassiosira sp.* from Izmir Bay it was aimed to point out the physiological properties of this species. Additionally, to form a base for model studies by parameterise its exponential growth rates, nutrient limiting growth rates and the Michealis-Menten curves that indicate dependence on nutrients. Being spread in a wide area of oligotrophic regions to eutrophic regions shows that these species' environmental adaptation is quite interesting. Nutrient enrichment experiments have been performed for determination of growth limiting nutrient for species in community and nutrient limited growth of them. MONOD kinetics equation was used for this purpose ([1],[2],[3],[4]).

Material and Methods

Izmir Bay is one of the largest and polluted bay of the Turkish Aegean coast. The Izmir Bay is divided into inner, middle and outer Bay due to topographical and hydrographical characteristics. The main pollutants affecting the bay water quality are organic matter, suspended matter, hydrocarbons, metals and pathogenic organisms. The pathways through which these pollutants reach the bay are domestic and industrial wastes, rainfall, bay activities and ship traffic, rivers and streams, erosion, agriculturel and other sources [5]. For this study, experiment bottles were conducted in a constant temperature room at optimal temperature of the species and irradiated at 1300 ftCd (foot-candle) by daylight fluorescent lambs. Cultures were maintained on a 12:12 light:dark cycle. For stock culture and batch culture experiments, f/2 and h/2 mediums were used described by [6]. The experiments were carried out in 1 liter Pyrex bottles initially containing 1 liter of seawater. For the experiment, the concentrations of nutrients in f/2 medium were changed and thus, for every nutrient, a different concentration was obtained. For the experiment groups, nutrients, trace elements and vitamins were added seawater according to f/2 medium [6]. Our experiment was performed under non-limiting nutrient, light and temperature conditions except the nutrient exposured. Ammonium, phosphate, silicate and nitrate were analysed by spectrophotometric methods ([7],[8]). All of the spectrophotometric analyses were carried out by using Bosch-Lomb Spectronic 21 UVD model spektrophotometer and also chlorophyll *α* analysis were performed using Turner 10-AU Model Fluorometer.

Results and Discussion

According to analytical results, background seawater concentrations are given below: Nitrate: 3.2 μM, Ammonium: 15.79 μM; RP : 2.6 μM and Silicate: 29.20 μM. When we examined the growth curves of *Skeletonema costatum* at the different concentrations of silicate, ammonium and phosphate, we found no limitation for these nutrients hence these nutrient concentrations are not reached to limiting values in natural marine environment. Estimated growth rate means are μ_{avg}: 2.06 day^{-1} for silicate, 1.97 day^{-1} for ammonium and 1.70 day^{-1} for RP. At the different concentrations of nitrate enrichment experiments we observed that the population of S*keletonema costatum* is not able to grow in low nitrate concentrations. In the previous study it was reported *S.costatum* is growing better in batch culture with high N:Si ratio [9]. In winter period (in February) *Skeletonema costatum* growth was limited by nitrate. The highest cell number was reached to 38 millions cell/L. at the concentration of 886.2 μM nitrate. Maximum spesific growth rate of *S. costatum* was calculated as 2.34 day^{-1} and half saturation constant (Ks) as 6.9 μM using Monod equation. There is no limitation observed at enrichment experimets of T*halassiosira sp*. for the different concentrations of silicate, ammonium and nitrate. Estimated average growth rates are μ_{avg}:1.49 day^{-1} for silicate, μ_{avg}:1.25 day^{-1} for ammonium and μ_{avg}:0.97 day^{-1} for nitrate in natural environment. Enrichment experimets of RP at 10 different concentrations, the highest cell concentration was observed at 38.9 μM and the growth was stopped at high concentrations. At low concentrations the growth limitation could be clearly seen. At the natural background concentration we deduce that the growth rate of *Thalassiosira sp*. was reduced 50%. Using Monod equation, estimated maximum growth rate for *Thalassiosira sp.* was μ_{max}:1.73 $day^{-1}$and Ks was 2.018 μM for RP. In conclusion, according to our experimental results, it was determined that species which do not need high silicate concentration were dominant in winter period. *Thalassiosira sp.* species' high phosphate uptake ability was limited by RP. *Skeletonema costatum*'s growth rate was limited by nitrate. Light density is low in winter at Izmir Bay. In this condition it is known that certain species uptake nitrate at the precence of ammonium and can produce lower energetic fotosenthetic productions [10]. We pointed out that this species has an adaptation ability from oligotrophic conditions to eutrophic conditions.

References

1 - Eppley, R.W., W.H. Thomas., 1969. Comparison of half-saturation constants for growth and nitrate uptake of marine phytoplankton. *J. Phycol*. 5:375-79.

2 - Droop, M. R., 1974.The nutrient status of algal cells in continuous culture. *J. Mar. Biol. Assoc. U.K. 54: 825–855.*

3 - Caperon, J., Meyer, J., 1972. Nitrogen-limited growth of marine phytoplankton. i. changes in population characteristics with steady-state growth rate. *Deep Sea Research 19: pp.601-618.*

4 - Thomas, W.H., 1969. Phytoplankton nutrient enrichment experiments off baja california and in the eastern equatorial pacific ocean. *Journal Fisheries Research Board of Canada, 26(5): pp. 1133-1145.*

5 - Sunlu, U., 2004. The state of the marine pollution in the bay of Izmir. Workshop on artificial reef applications in fisheries and water quality enhancement. 24/09/2004. E.U. Faculty of Fisheries. Urla-Turkey.

6 - Guillard, R.R.L., 1975. Culture of phytoplankton for feeding marine invertebrates. in: Smith, W.L. and M. H. Chanley (Eds.), *Culture of Marine Invertebrate Animals.* Plenum Press, New York, NY.

7 - Strickland, J. D. H., T. R. Parsons., 1972. A pratical handbook of seawater analysis. *Fisheries Research Board of Canada. Bull.* 167. Ottowa, 310 p.

8 - Wood, R., 1975. Hydrobotanical meth. Univ. Park Press., Baltimore., *173p.*

9 - Roberts, Ec., Davidson, K., Gilpin, C., 2003: Response of temperate microplankton communities to N:Si ratio perturbation. *Journal of Plankton Research*. Vol. 25, Number. 12, 1485-1495.

10 - Levasseur, M., P.A. Thompson, P.J. Harrison., 1993. Physiological acclimation of marine phytoplankton to different nitrogen sources. *J. Phycol. 29, 587-595*.

THE COMPARISON OF K_S VALUES OF *CHAETOCEROS GRACILIS* ISOLATED FROM THE BAY OF IZMIR AND HOMA LAGOON

Banu Kutlu [1]*
[1] Tunceli University - banukutlu@tunceli.edu.tr

Abstract
Diatoms contribute to the global carbon cycle and they have an important role in regulating climates by using 40 percent of carbon in oceans [1]. *Chaetoceros gracilis* were exposed to various concentrations of NH_4^+-N based on f/2 medium in order to determine which nutrients have a limited effect on the growth of *C. gracilis* . As a result, while μ_{max} values of the *C. gracilis* isolated from two different medium are approximate, their Ks values are different. This may be related to the water's nutrient value.
Keywords: Algae, Biokinetics, Chlorophyll-a

Introduction
Unicellular marine algae are used as food for marine organisms which have commercial value. *Chaetoceros* sp, in particular, have good nutritional value because of their small cell structures and unsaturated fatty acids. They are widely used as food for cructaceans, mollusks and fish in larval stage in aquaculture.

Materials and methods
Izmir Bay: The bay of Izmir is located in the Western part of Turkey and surrounded by a densely populated community. The bay is divided into the Inner, the Middle and the Outer Bay from the standpoint of topographical and hydrographical characteristics. The Inner bay occupies a small area and is shallow in depth. Homa Lagoon: This study was conducted in the Homa (Sufa) Lagoon area located at the outer part of Izmir Bay. Microalgal Culture: For this study *C.gracilis* was isolated from Izmir Bay (Aegean Sea) and Homa lagoon. At the time of the study, cultures of *C .gracilis* were unialgal but non-axenic. *C. gracilis* cultures were grown in 21 Erlen mayer flasks containing 1.5 of sterile f/2 medium [2]. Experiments were conducted at a constant room temperature at 28 C and irradiated at 52 µmol/m^2s by daylight fluorescent lamps. Specific-growth rates: chlorophyll a specific growth rates were calculated from chlorophyll a concentrations during experimental growth. The specific growth rate was obtained from each growth curve calculating the following equation. $\mu = 1/ (t2–t1)*\log 2(N2/N1)$

Result and discussion
Another parameter, without doubt, is nutrients which have an affect on the growth of algae that have been taken from two different environments after they were isolated. *Chaetoceros gracilis* were exposed to various concentrations of NH_4^+-N on f/2 medium in order to determine which nutrients have a limited effect on the growth of *C. gracilis.* Ks, which is regarded as the affinity of *C.gracilis* in terms of nutrient in two regions, is used as the index of species' potential survival capacity in low density food concentrations [3]. The value is > 1 µgat/L and it indicates that the waters of the Bay of Izmir and Homa lagoon aren't very poor in terms of NH_4^+-N. But this value is greater in Homa lagoon. The difference of the calculated K_s value (3.86) can be explained by the fact that the aforementioned species may be showing environmental adaptation to the lagoon. Besides, the maximum growth rates of the cells grown in ammonium are greater than those grown in nitrate and this may be originating from the cells of species, which go into the other phases of life. μ_{max} values of Homa lagoon and Bay of Izmir are the same [4]. Found the Ks values of *C. gracilis* species, which have been isolated from waters poor in nutrients, as 0.1 Nm. As a result, while μ_{max} values of the *C. gracilis* isolated from two different medium are approximate, their Ks values are different. This may be related to the water's nutrient value.

References
1 - Nelson D.M., Treguer P., Brzezinski M.A, Leynaert A., Queguiner B., 1995. Production and dissolution of biogenic silica in ocean: revised global estimates, comparison with regional data and relationship to biogenic sedimentation, Glob. Biogeochem., Cycles 9:359–372.
2 - Guillard, R.R.L and Rhther J.H., 1962. Studies on marine planktonic diatoms I. *Cyclotella nana* Hustedt and *Detomula Confervacae* (Cleve). Gran. Can. J. Microbiol., 8:229-239
3 - Smayda, T.J., 1997. Harmful blooms: Their ecophysiology and general relevance to phytoplankton blooms in the sea. Limnon. Oceanogr., Vol. 425 pp.1137-1153.

NUTRIENT ENRICHMENT BIOASSAY IN THE HOMA LAGOON (IZMIR BAY, AEGEAN SEA)

Banu KUTLU [1]*, Murathan KAYIM [2], Erkan CAN [2] and Baha BÜYÜKISIK [3]
[1] Tunceli University/ Fisheries faculty, Turkey - kutlubanu@gmail.com
[2] Ege University/Fisheries Faculty, Turkey
[3] Faculty of Fisheries, Ege University, Bomova 35100, Izmir, TURQUIE

Abstract
The Homa lagoon is the enclosed bay of Izmir which has been subjected to a variety of human influences such as agriculture in the surrounding area. In this study, bio-chemical system was studied using some biological, chemical and physical parameters obtained from the Homa lagoon. Temperature, salinity, NH_4 + - N, NO_3 - N, PO_4 - P, Si, *in vivo* Chl-a were measured. To determine the variation of the parameters and to assess the dynamics between the nutrients and the microplankton of the Homa lagoon, nutrient enrichment bioassays were performed from the selected main sampling station. During the spring bloom of 2006, four main growths were observed. The first one appeared as bloom of *Chaetoceros* sp. In he second growth, an increase of *Licmophora abbreviata* algae was observed. In the third one, *Tintinopsis beroidea* appeared.
Keywords: Biokinetics, Chlorophyll-a

Introduction
Homa lagoon is a natural fish production area in the Izmir. The Homa lagoon is the enclosed bay of Izmir which is subjected to a variety of human influences such as agriculture in the surrounding area. Nutrient inputs from agriculture are the main antropogenic pollution source. In this study the bio-chemical structure was investigated using some biological, chemical and physical parameters obtained from the Homa lagoon. Temperature, salinity, NH_4 -NO_3, PO_4, Si, Chl-a were measured. To assess the dynamics between the nutrients and the microplankton of the Homa lagoon, nutrient enrichment bioassays were performed from the selected main sampling station. The region where the lagoon water and the sea water converge is determined as the station. Nutrients were added into the experimental bottles to find out growth curves and kinetic parameters. The obtained data were plotted as growth curves and chl-a based exponential growth rates were calculated. Growth rates as a function of nutrient concentrations were fitted to the monod equation.

Methods and Materials
Water for nutrient samples was collected in 100 ml polyethylene cans. (Nitrate+Nitrite)-nitrogen (NO_3+NO_2)-N, reactive phosphorus (RP), reactive silicate (RSi) were measured spectrophotometrically according to Strickland and Parsons [1]. During the sampling periods bioassay samples were collected from Homa lagoon. Water samples in pet carboys were filtered from 245 micrometer (µm) plankton net to remove mesozooplankton and distributed to the experimental bottles. *In situ* conditions were simulated in the laboratory by using constant temperature and light room (52 µmol/m light intensity). Experiments were carried out in March, April and May 2006 to find out about nutrient limitation and to assess phytoplankton community. Nutrients such as nitrogen, phosphorus, silica were added to the one litter bottles which contained seawater sample. This known nutrient concentration enrichments help find out growth rate. The obtained data were plotted as growth curves and chl-a based exponential growth rates were calculated. Growth rates as a functions of nutrient concentrations were fitted to monod equations.

Result and discussion
The surface waters of the main station are rich in chl-a for most of the year. In spring bloom, the values were as follows: 2006, (NO_3-N + NO_2-N (4.03 - 7.25), RP (0.62-0.97), RSi (13.15-19.15) µ gat/l. The values ranged in (mM) for the analyses in May 2006 (NO_3-N + NO_2-N (6.41 - 12.27), RP (0), RSi (1.19-9.83). The surface molar ratios of nitrogen to phosphate (N/P) were calculated as 2.98 in spring time. Temperature values ranged between 15 and 22°C in March, April, and May 2006. Salinity values ranged between 36 and 44.716 psu in March-April and May respectively. Spring bloom time fourth main growths were observed. The first one appears as bloom of *Chaetoceros sp*. In the second growth, there was an increase of *Licmophora abbreiata*. The third one was *Tintinopsis beroidea*. After all these observations, the specimens of copepod were seen in the bay. Bio assay experiments can be summarized as follows. Phytoplankton level of most of the experimental bottles reached the exponential phase immediately, while some of the bottles exhibited lag phase (for NO_3-N up to 4.11 µM). The greatest variation took place for Max chl-concentrations and phosphate concentrations. Growth rate and carrying capacity were calculated by formula 1 and 2 respectively. Results of the growh rate and chl a max for NH_4 are calculated as µ = 2,54 and Chl a max *in situ* = 12.12.

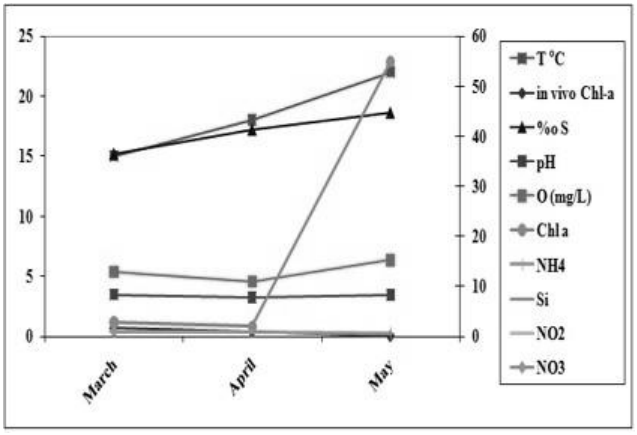


Fig. 1. Physico-chemical parameters

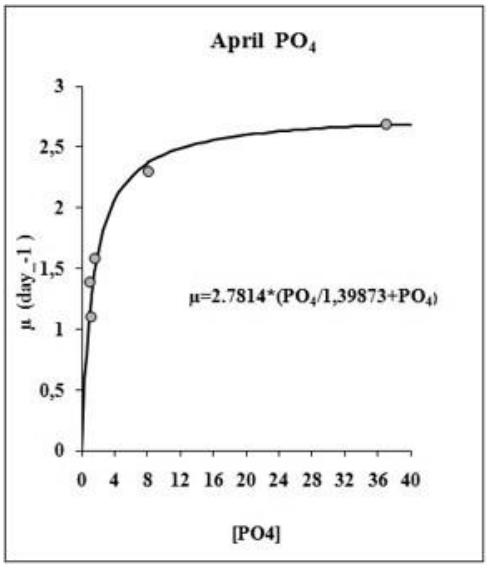


Fig. 2. Growth rate with PO4-P

References
1 - Strickland, J.D.H., Parsons, T.R., 1972, A practical handbook of seawater analysis, fisheries research boards of Canada. Bull, 167, Ottawa, pp:310.

ARCHAEAL DIVERSITY AT SHALLOW HYDROTHERMAL SYSTEM OFF PANAREA (EOLIAN ARCHIPELAGO, ITALY) AS REVEALED BY 16 S RDNA PCR-DGGE ANALYSIS

Valeria Lentini [1]*, Concetta Gugliandolo [1] and Teresa Luciana Maugeri [1]
[1] Dip. di Biologia Animale ed Ecologia Marina , Università di Messina,V.le F. Stagno d'Alcontres, 31, 98166 Messina, Italy - vlentini@unime.it

Abstract
A molecular phylogenetic survey of occurring archaeal diversity at four different shallow hydrothermal vents was carried out by using the 16S rDNA PCR-DGGE fingerprinting method. Most of retrieved archaeal sequences did not match with those of yet-described *Archaea*, suggesting the presence of new archaeal genotypes.
Keywords: Aeolian Arc, Biodiversity, Thermal Vents

The shallow marine hydrothermal vents of the Eolian Islands in the Tyrrhenian Sea are located in tectonically active areas and despite their accessibility, several aspects concerning microbial ecology of these ecosystems have been much less investigated than those of deep-sea vents. Among Eolian Islands, thermal springs and shallow hydrothermal vents of Vulcano are considered the "type locality" of hyperthermophilic *Archaea*. Very few studies have been concerned the microorganisms living at near hydrothermal system of Panarea Island [1,2,3]. On the basis of culture-dependent techniques, microbial communities of extreme environmentswere thought to be dominated by *Archaea* [4,5]. The recent application of molecular methods revealed a different picture, in which *Bacteria* dominated the microbial communities in most of these environments [2,3]. Here we report the archaeal diversity studied by molecular tools in environmental samples collected from four shallow thermal sites characterised by different temperatures and depths located off Panarea Island. Archaeal diversity was investigated by means of 16S rDNA PCR-DGGE fragment analysis, as previously described [2]. DGGE profiles showed that total number of bands, equivalent to the archaeal richness, was higher in water (24) than in sediment samples (18). Comparison among the DGGE profiles, performed on the basis of Bray-Curtis similarity coefficient, showed low similarity levels among vents, suggesting that archaeal community was differently distributed at four sites, according to physico-chemical parameters. The similarity matrices were also used for constructing a non-metric multidimensional scaling (NMDS) diagram (Fig. 1).

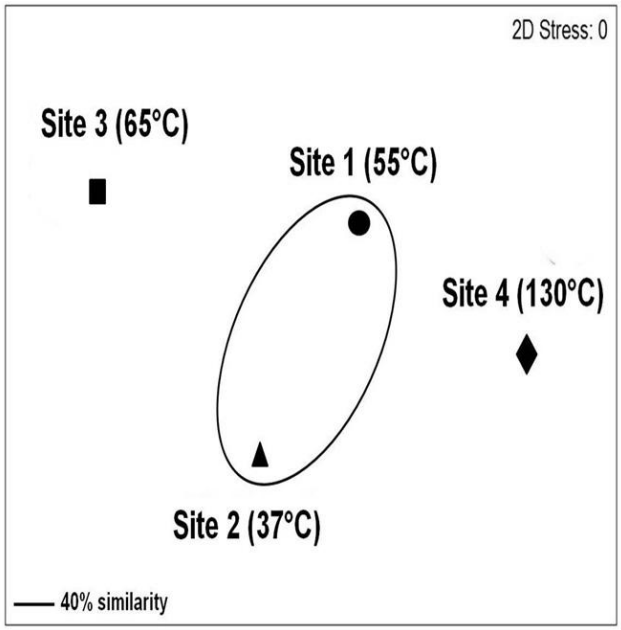


Fig. 1. NMDS diagram showing the clustering of the archaeal community

Phylogenetic analysis revealed that most of the archaeal DGGE 16S rRNA gene sequences matched with uncultivated *Archaea* and these results did not allow us to speculate about their physiology. Only two sequences, obtained from sites 1 and 4, were distantly affiliated (<96% similarity) with *Paleococcus helgesonii*, an obligate chemo-heterotrophic, hyperthermophilic, microaerophilic euryarcheon, recently isolated from a geothermal well at Vulcano Island [6]. The low similarity levels of sequences with yet-described clones of *Archaea* suggest the presence of new indigenous archaeal phylotypes.

References
1 - Gugliandolo C., Italiano F. and Maugeri T.L., 2006. The submarine hydrothermal system of Panarea (Southern Italy): biogeochemical processes at the thermal fluids - sea bottom interface. *Ann. Geophysics*, *49*: pp 783-792.
2 - Maugeri T.L., Lentini V., Gugliandolo C., Italiano F., Cousin S. and Stackebrandt E., 2009. Bacterial and archaeal populations at two shallow hydrothermal vents off Panarea Island (Eolian Islands, Italy). *Extremophiles*, 13: 199-212.
3 - Manini E., Luna G.M., Corinaldesi C., Zeppilli D., Bortoluzzi G., Caramanna G., Raffa F., and Danovaro R., 2008. Prokaryote diversity and virus abundance in shallow hydrothermal vents of the Mediterranean Sea (Panarea Island) and the Pacific Ocean (North Sulawesi-Indonesia). *Microb. Ecol.*,55: 626-639.
4 - Stetter K.O., Fiala G., Huber R. and Segerer A., 1990. Hyperthermophilic microorganisms. *FEMS Microbiol. Rev.*, 75: 117-124.
5 - Baross J.A. and Deming J.W., 1995. Growth at high temperatures: isolation and taxonomy, physiology, and ecology. *In*: Karl DM (ed.), The microbiology of deep-sea hydrothermal vents. CRC Press. Boca Raton, pp 169-217.
6 - Amend J.P., Meyer-Dombard D.R., Sheth S.N., Zolotova N. and Amend A.C., 2003. *Palaeococcus helgesonii* sp. nov., a facultatively anaerobic, hyperthermophilic archaeon from a geothermal well on Vulcano Island, Italy. *Arch. Microbiol.*, 179: 394-401.

VIRIOPLANKTON AND BACTERIOPLANKTON DYNAMIC IN AN ITALIAN COASTAL AREA OF THE SOUTHERN ADRIATIC SEA SUBJECTED TO POLLUTION

Maria Ilaria Leopizzi [1], Loredana Stabili [2]*, Federica Lugoli [1] and Antonella De Donno [1]
[1] Istituto per l'Ambiente Marino Costiero (IAMC)-CNR, U.O.S. Taranto - loredana.stabili@iamc.cnr.it
[2] DiSTeBA, Unviersità del Salento

Abstract
The discovery that viruses may be the most abundant organisms in marine ecosystems, surpassing the number of bacteria by an order of magnitude, has inspired a resurgence of interest in viruses in the aquatic environment. In the present study we evaluated the virioplankton, total culturable heterotrophic bacteria, luminous bacteria, *Escherichia coli* and somatic coliphages abundances, over an annual cycle, at two sampling points located in the Southern Adriatic Sea (Italy) differently subjected to a sewage pipe impact.
Keywords: Adriatic Sea, Bacteria, Bio-Indicators, Sewage Pollution

Introduction
Coastal marine ecosystems are characterised by a complex set of dynamic interactions between organisms including viral lysis [3]. Marine viruses are the most abundant biological particles in the sea [4]. The evidence to date suggests that virioplankton communities are mainly composed of bacteriophages and that by specifically infecting heterotrophic bacteria, virus are likely to play critical roles in the structure and function of aquatic food webs[1]. Although an increasing number of work has been conducted on marine viruses, little is known about their biology and ecology (relationships with hosts and the environment) in the Southern Adriatic Sea Italian coasts. The aim of this study was to describe the virioplankton, total culturable heterotrophic bacteria, luminous bacteria, *Escherichia coli* and somatic coliphages abundances over an annual cycle as well as the relationships between these planktonic components at two sampling points located in a coastal area of the Southern Adriatic Sea (S. Cataldo, Lecce, Italy). The former point was near the mouth of a sewage pipe and the latter at 1000 m from the pipe.

Material and Methods
Water samples were collected from surface (0.2 m depth) in 300 ml capacity sterilized glass containers. To enumerate viruses water samples were filtered through 0.02 µm pore-size filters, stained with SYBR Green I and observed by an epifluorescence microscopy. For enumeration of heterotrophic and luminous bacteria the number of colony forming units was determined by plating 1 ml of undiluted seawater in triplicates on Complete Seawater. The plates were incubated at 21°C for 20-24 hours. *Escherichia coli* presence was assessed through the filtering membrane technique. Somatic coliphages were detected through the double-layer agar technique, after a tangential flow ultrafiltration (on 10 l of water) to increase the recovery capability for phages.

Results and Discussions
Our results indicated that microbial parameters displayed a much higher abundance in the polluted point where the mean virioplankton abundance was 1.2 x 10^7 cells/ml and mean culturable heterotrophic bacteria density was 6 x 10^3 cells/ml. Furthermore viral density followed the pattern of luminous bacteria abundance as confirmed by regression analysis [2]. In the impacted point the highest concentrations of *Escherichia coli* were recorded in the summer-autumn period (100 c.f.u./100ml) whilst in January they showed values near to zero. By contrast, in the point at 1000 m from the discharge pipe, somatic coliphages concentration recorded the highest value (128 p.f.u./100ml) in the coldest month (January). Our results show that somatic coliphages are less sensitive to temperature than the classical indicators of faecal contamination. These findings suggest that somatic coliphages could be used as indicators to evaluate the quality of coastal seawater, in order to provide a more accurate analysis of the hygienic-sanitary quality of the marine ecosystem.

References
1 - Fuhrman J.A. and Schwalbach M., 2003. Viral influence on aquatic bacterial communities. *Biol. Bull.*, 204: 192-195.
2 - Perego P., Fanara L., Zilli M. and Del Borghi M., 2002. Applications of luminous bacteria on environmental monitoring. *Chem. Biochem. Eng Q.*, 16: 87-92.
3 - Weinbauer M.G., 2004. Ecology of prokaryotic viruses. *FEMS Microbiol. Rev.*, 28: 127-181.
4 - Wommack K.E. and Colwell R.R., 2000. Virioplankton: viruses in aquatic ecosystems. Microbiol. *Mol. Biol. R.*, 64: 69-114.

ON THE GENETIC STRUCTURE OF *RUDITAPES DECUSSATUS* (MOLLUSCA, BIVALVIA) INFERRED BY NUCLEAR AND MITOCHONDRIAL GENETIC MARKERS.

A. Manunza [1], D. Mascia [1], R. Demurtas [1], A. M. Deiana [1] and R. Cannas [1]*

[1] Com.Bio.Ma Centro di Competenza sulla Biodiversità Marina. Dipartimento di Biologia animale ed ecologia – Università di Cagliari - rcannas@unica.it

Abstract

Analyses of 478 polymorphic AFLP loci and about 540 base pairs COI provided an account of genetic variation among *Ruditapes decussatus* populations from both the French Atlantic coast and the Mediterranean Sea. AFLP analyses of 357 specimens from 17 locations revealed evidence of significant genetic differentiation among populations (Fst = 0.16; P<0.001). Data on COI sequences from Mediterranean and Atlantic populations showed a lower genetic diversity among populations. Mismatch analysis found signatures of past genetic bottlenecks in *R. decussatus* populations. These findings confirmed the utility of AFLP for population genetic study while indicated that COI sequences, characterized by a lower intraspecific variability, could be more suitable markers for evolutionary studies

Keywords: Western Mediterranean, Genetics, Bivalves, Aquaculture, Lagoons

Introduction

The grooved carpet shell clam *Ruditapes decussatus* is a bivalve well appreciated for human consumption and one of the most expensive and commercially important clam species in fishery and aquaculture for the Mediterranean countries. Since wild stocks in most of the *R. decussatus* native range have been in decline over the last decades, to ensure a successful species management, it is extremely important to monitor the genetic variability both natural and hatchery populations. In the present study we examined both nuclear (AFLP) and mitochondrial DNA (COI) variation among samples of the Mediterranean basin and Atlantic Ocean with the goal of characterize its populations.

Material and methods

The majority of samples were collected in lagoons of the western Mediterranean basin: along the Sardinian coasts (n=10), in the Adriatic (Italy and Albania, n=4), in the Thau Lagoon (France, n=1), in the Ebro Delta (Spain, n=1). One sample came from the Arcachon lagoon (Atlantic coast, France). AFLP marker profiles were generated using the procedures described in [1] with minor modifications. Allele frequencies were estimated with AFLP-SURV v. 1.1. Genetic diversity within and among populations were estimated with ARLEQUIN 3.1 [2], and COA analysis using Adegenet [3]. Partial sequences of the mitochondrial COI gene were obtained using novel internal primers designed from the partial mitochondrial sequence of *Ruditapes decussatus* (GenBank Accession DQ184830). All sequences were aligned with MEGA 4 [4] and analysed with DnaSP 5.1 [5], and ARLEQUIN 3.11.

Results

AFLP analysis was successfully performed on all 357 individual samples and the two selected primer combinations produced a total of 478 polymorphic markers. Among populations, the percentage of polymorphic loci ranged from 41.6 % to 60.9%, the expected heterozygosity values were generally low (from 0.14 to 0.17). AMOVA showed a high genetic differentiation among populations (Fst = 0.16, P<0.001), with most of the total variation (83.7%) due to intra-population differences. Among all hypothetical groupings of populations examined, several were found to have significant percentage of among-groups variation but the higher differentiation were measured when populations were clustered according to their genetic distances and not to their geographic origin (Tab. 1: Structure A - 4 groups= Atlantic/ Adriatic/ Sardinia/ WMediterranean; Structure B - 3 groups= WMediterranean+Albania/ SGilla (3sites)/ all others). In particular, COA analyses confirmed these results (Fig. 1). Nucleotide sequences of about 540 bp in length were obtained from the mitochondrial cytochrome C oxidase subunit I (COI) gene. Analysis of sequence variation revealed the occurrence of 19 variable sites, a low nucleotide diversity (π: 0,00203) and haplotype diversity (Hd: 0.565). The most common haplotype was found in about 60% of the specimens and in all populations; other two less frequent haplotypes were present. Contrary to what is shown by the AFLP data, COI sequences seems to indicate that populations are not significantly differentiated. Mean overall Kimura genetic distance was K2P=0.2%, and pairwise inter-population distances ranged from 0.1% to 0.4%. The mismatch analysis and the star-like maximum parsimony network of COI sequences indicate the occurrence of past bottleneck events followed by recent population expansions of *R. decussates* populations. Our study confirm the utility of amplified fragment length polymorphism (AFLP) markers for population genetic studies; they permitted to retrieve a higher genetic diversity, and were developed at a relatively low cost and in a short period of time, which can make them ideal tools for generating large data sets for species that need a continuous monitoring. On the contrary, mitochondrial sequences resulted to be far less variable, and could be more suitable for evolutionary studies.

Tab. 1. AMOVA results of *Ruditapes decussatus* from AFLP data

Source of variation	%variation	F index
Structure A° (geographic clusters)		
Within populations	5.97	0.06**
Among groups	12.16	0.13***
Among populations within groups	81.87	0.18***
Structure B° (genetic clusters)		
Within populations	12.95	0.13***
Among groups	7.67	0.09***
Among populations within groups	79.37	0.21***

= Pvalue <0.01,*= value<0.001, ° see text for Structure details

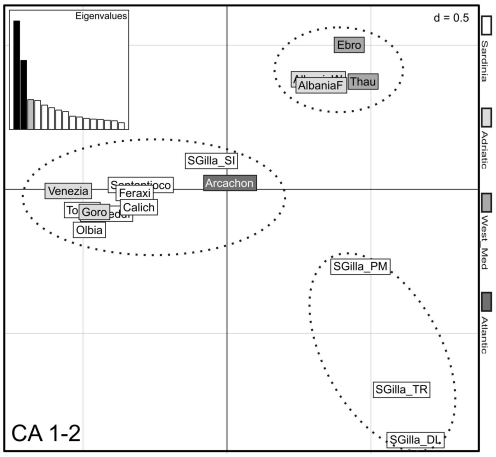


Fig. 1. COA (COrrespondance Analysis) of *Ruditapes decussatus* from AFLP data. Eigenvalues corresponding to the represented components are filled in black

References

1 - Ajmone-Marsan P, Valentini A, Cassandro M, Vecchiotti-Antaldi G, Bertoni G, Kuiper M., 1997. *Anim Genet.* 28(6):418-26.

2 - Jombart T., 2008. *Bioinformatics* 24: 1403-1405.

3 - Excoffier L., Laval G., Schneider S., 2005. Bioinformatics Online, 1, 47-50.

4 - Tamura K, Dudley J, Nei M & Kumar S., 2007. *Molecular Biology and Evolution* 24:1596-1599.

5 - Librado, P. and Rozas, J., 2009. DnaSP v5: *Bioinformatics* 25: 1451-1452.

SALT MARSH ACCRETION BY ENDOGENOUS CYANOBACTERIA TO REDUCE EROSION IN VENICE LAGOON

Davide Marchetto [1], Giovanni Cecconi [2], Claudia Cerasuolo [2] and Franco Baldi [1]*
[1] Department of Environmental Sciences, Cà Foscari University - baldi@unive.it
[2] Consorzio Venezia Nuova - Thetis, Venezia

Abstract
Different strains of cyanobacteria were isolated from salt-marsh of Venice Lagoon. One of them was used in the laboratory to colonize artificial substrates to induce a better colonization of eroded sediments. Different materials for cyanobacteria colonization were used from silica, zeolite to sediments. Different tests were made to improve cyanobacteria survival and exo-polysaccharide production under diverse conditions to consolidate sediments.
Keywords: Cyanobacteria, Sediments, Erosion, Lagoons



Fig. 1. Eroded sediments in the Northern Lagoon of Venice

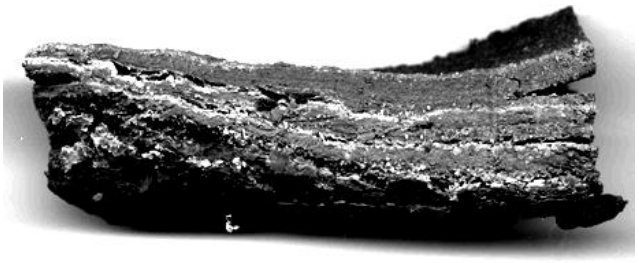


Fig. 2. Natural stratified sediments colonized by filamentous cyanobacteria

During the last century the Venice lagoon wetlands underwent to a severe reduction of intertidal shoals and salt marshes. These geomorphologic components of the lagoon are particularly vulnerable and they have been already affected by intense erosion (Fig. 1) passing from 17.0% to 8.8% [1]. By many observations we know that cyanobacteria in the Venice Lagoon form stratified sediment (Fig. 2). These structures are very stable and consolidate sediments by naturally reducing the erosion. The aim of this work was to mitigate this process by promoting the consolidation of sediment surface with endemic cyanobacteria mat, by growing these autotrophic bacteria on suitable solid substrates to seed and colonize sediments in order to understand the colonization process for facilitating the self-preservation of salt-marsh habitats.
Cyanobacteria were isolated from salt marshes sediment in the northern basin of Venice Lagoon using solid media ASN-III [2]. A filamentous cyanobacteria strain was selected among other isolates. The strain CyV3 was used in colonization experiments on sandy quartz, commercial zeolites grain and natural lagoon sediments. The growth and adhesion of bacteria were followed on these substrates by determining photo pigments, carbohydrates, uronic acids, exopolysaccharides (EPS) and proteins. Adhesion of cyanobacteria on sediments was also studied with epifluorescence microscopy using PNA lectine and other conventional fluorochromes. Experiments were performed also in microcosmos, using lagoon sediments to study cyanobacteria colonization. Four glassware vessels containing each 1 kg of sediments, sampled from the same salt marsh station, were used for the experiment with natural and autoclaved sediments with and without additions of cyanobacteria grown on porous zeolite. These experiment was followed for 15 days and all parameters were determined to understand the colonization process.
The CyV3 strain, belongs to Phormidium sp, grown significantly faster than other isolated strains and so we use this strain to reproduce at the multilayers structure (Fig 2). The strain was grown on coarse silica sand and fine zeolite: the growth was faster in silica but the material consolidation was weak. With finer grains of zeolites, the growth rate was longer but CyV3 produced higher amounts of ESP and total carbohydrates to give a more consolidate structure.
So commercial zeolite grains (0.5 cm diameter) colonized by strain CyV3 were used to seed CyV3 strain in microcosmos with lagoon sediments. The cyanobacteria viability and reproducibility on colonized zeolites was monitored for two months. The same percentage of viability was maintained for two weeks, after a sensitive decrease of viability with an extended lag-phase was observed. Results of experiments in the four microcosms indicated that a strong microbial competition occurred in natural sample so cyanobacterial strain seeded on zeolite did not produce significant augmentation of cyanobacteria population in relation to native autotrophic population. Conversely, the inoculated cyanobacteria zeolite grains in sterilized sediments gave a wide contribution to the formation of consolidated cyanobacterial mat.

Acknowledge : This research was partially supported by Ministry of Infrastructures and Transports - Magistrato alle Acque through its concessionary Consorzio Venezia Nuova.

References

1 - Cecconi G. and Ardone V., 2000. La protezione dell'ambiente lagunare e costiero veneziano. Mare e cambiamenti globali, 181-198.
2 - Waterbury J. B. and Stanier R. Y., 1981. Isolation and growth of cyanobacteria from marine and hypersaline environments, in Starr, Stulp, Truper, Balows, Schleeper: The prokaryotes: a handbook on habitats, isolation, and identification of bacteria, Vol 1. Springer-Verlag, Berlin, 221–223.

MICROSATELLITE MARKERS FOR POPULATION GENETIC STUDIES OF THE GIANT RED SHRIMP *ARISTAEOMORPHA FOLIACEA* (CRUSTACEA, DECAPODA)

Sandro Marcias [1], Flavio Sacco [1], Alessandro Cau [1] and Rita Cannas [1]*

[1] Com.Bio.Ma. Centro di Competenza sulla biodiversità marina, Dipartimento di Biologia animale ed ecologia, Università degli Studi di Cagliari - rcannas@unica.it

Abstract

Microsatellite markers have been isolated and characterized from the giant red shrimp *Aristaeomorpha foliacea* in order to investigate on the presence of distinct stocks in the Western Mediterranean Sea. Polymorphism of the newly obtained loci was assessed in a restricted sample of 30 specimens, nine loci provided markers with polymorphism (range 2–19 alleles per locus). Six loci, the most polymorphic and easiest to amplify and to score, were tested in a larger sample of 6 populations from the Western Mediterranean Sea. Microsatellite data revealed a substantial genetic homogeneity and no signs of recent bottlenecks, suggesting the existence of a high gene flow that connects all populations.

Keywords: Genetics, Crustacea, Western Mediterranean, Deep Waters, Fisheries

Introduction

The giant red shrimp, *Aristaeomorpha foliacea*, is a cosmopolitan crustacean species, widespread in the eastern and western Atlantic, the western Pacific, the Indian Ocean and the Mediterranean Sea. It is one of the most important exploited crustaceans, having a long traditional and economical significance for the deep fishery of the western and central Mediterranean countries. Despite its commercial importance, little is known about the genetics, population structure, and migration patterns of this species. Since direct tracking movements of individuals is very difficult for marine species, the use of indirect methods, including genetic approaches, for the measurement of connectivity among populations can be very informative. With the aim of studying the population structure and genetic connectivity among giant red shrimp populations from the Western Mediterranean Sea and obtaining new and powerful genetic markers, microsatellites loci were isolated from *Aristaeomorpha foliacea* genome using the FIASCO protocol [1] from a partial genomic library enriched for an AC motif.

Results

Among 96 recombinant clones obtained, a total of 43 sequences had a microsatellite, 14 of which with flanking region of appropriate length and sufficient quality to allow the design of primers that were used to amplify the genomic DNA of a subsample of 30 specimens from two locations. Four out of 14 microsatellites were immidiately discarded because of their low amplification success, while one was found to be monomorphic.

The remaining 9 loci were characterized by a high variability in PIC values (0.36-0.91) and in the number of alleles (range 2 – 19).

In this study only the 6 most polymorphic loci were tested in a larger sample and used to make a preliminary investigation on the genetic structure of Mediterranean giant red shrimps. A total of 115 specimens were analysed from 6 populations: 4 samples were collected off the Sardinian coast (Sant'Antioco, Cagliari, Siniscola, Asinara) and two samples off Sicily (Messina and Sicily Channel). Two loci (Cea17 and Cia82) significantly deviated from HWE and this could be explained by their associated elevated frequencies of null alleles (10% and 19%, respectively) calculated with the algorithm of Dempster [2]. *A. foliacea* populations resulted not genetically differentiated as indicated by the low and not significant pair-wise Fst values calculated with Arlequin 3.1 [3].

Analysis of molecular variance AMOVA clearly showed that genetic variability was largely due to differences among individuals (99.31%) rather than to differences among populations (0.69%).

The absence of population structure was further confirmed by the bayesian clustering method implemented in Structure 2.3 [4] indicating K=1 as the most probable structure.

The PCA performed with Adegenet [5] showed a substantial genetic homogeneity among populations separated by hundreds of kilometres suggesting that western Mediterranean populations could represent a unique panmictic stock (fig 1).

Finally, the bottleneck test [6] and interlocus g-tests [7] did not find signs of recent bottlenecks (reduction of population size) or growth (increase of population size after the recovering from a demographic collapse), leading to hypothesize that, up to now, the Western Mediterranean giant red shrimps have experienced a sustainable fishing pressure.

All these results clearly indicate that the microsatellite markers tested here can represent very useful tools for population genetic studies of *A. foliacea*, for instance for monitoring the detrimental genetic effects of any future increasing fishing pressure.

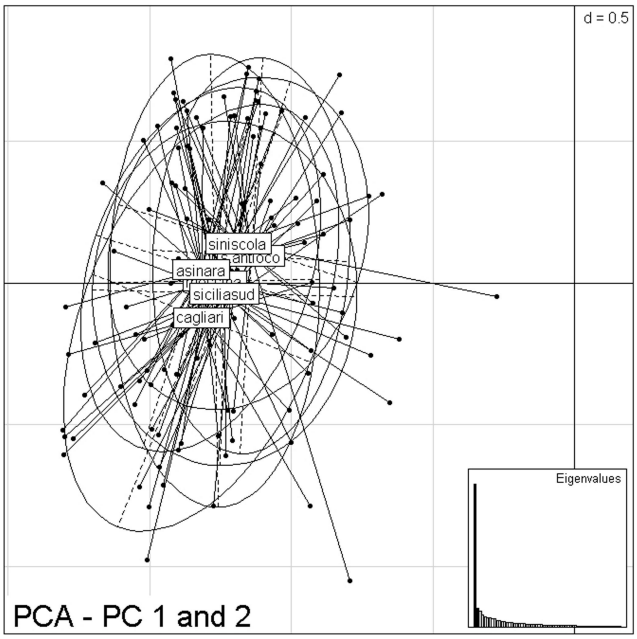


Fig. 1. Typology of giant red shrimp populations obtained by interclass PCA. Eigenvalues corresponding to the represented components are filled in black. Points represent genotypes; samples are labelled inside their 95% inertia ellipses

References

1 - Zane L., Bargelloni L., Patarnello T. 2002., *Molecular ecology* 11(1): 1-16.

2 - Chapuis M-P, Estoup A. 2007., *Mol Biol Evol*. 24: 621–631.

3 - Excoffier, L. G. Laval, and S. Schneider. 2005., *Evolutionary Bioinformatics* Online 1: 47-50.

4 - Falush, D., Stephens, M., and Pritchard, J. K., 2007. *Molecular Ecology Notes* 7(4): 547-578.

5 - Jombart T. 2008., *Bioinformatics* 24: 1403-1405.

6 - Piry S., Luikart G., Cornuet J.M. 1999., *Journal of Heredity*, 90: 502– 503.

7 - Reich D.E., Feldman M.W., Goldstein D.B. 1999., *Mol. Biol. Evol*. 16, 453-466.

DIVERSITY AND ABUNDANCE PATTERNS OF PHYTOPLANKTON IN COSTAL WATERS OF THE NORTHERN ADRIATIC

D. Maric [1]*, J. Godrijan [1], M. Pfannkuchen [1], T. Djakovac [1] and R. Precali [1]
[1] Center for marine research, Institute Rudjer Boskovic - daniela.maric@cim.irb.hr

Abstract
The distribution and abundance of different phytoplankton groups and species composition are described for costal waters along the Istrian peninsula and Kvarner Bay, in the northern Adriatic. Hydrochemical and biological properties were investigated during one year. The coastal system is rather heterogeneous due to the influence of several rivers and other anthropogenic inputs in the system, but also due to hydrography and complex circulation system in this area. The microphytoplankton community was dominated by diatoms while the dinoflagelates appeared when the nutrients were scarce, generally after the diatom blooms. The general trend followed expected succession patterns.
Keywords: Adriatic Sea, Phytoplankton, Coastal Waters

Introduction
Along the northern Adriatic (NA) coast the ecological factors (anthropogenic, like e.g. nutrient input as well as naturally e.g. bathygraphy and river outflows) are diverse. Hence the phytoplankton community is under equally diverse influences and any disturbance in marine ecosystem is strongly affecting the primary production at the first trophic level.

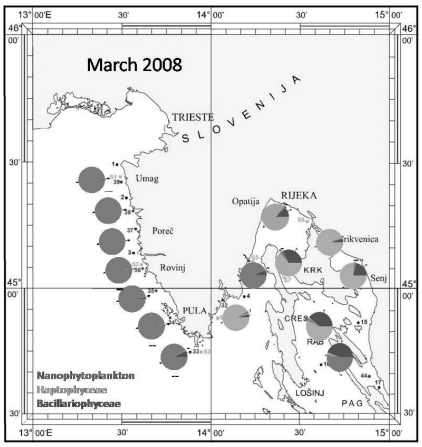


Fig. 1. The investigated area with the sampling stations. The piecharts show the phytoplankton community structures in March 2008.

Materials and Methods
Water samples were collected during seven cruises at 15 stations, each, one, nautical mile from the Istrian coast and Kvarner Bay (NA) during 2007 and 2008 (Fig.1). Temperature and salinity were measured using a CTD probe (Seabird, USA). A total of 315 water samples were analyzed during the study period. Samples were collected with 5 L Niskin bottles, subsamples for the determination of the nutrients were preformed using standard oceanographic methods (1). Phytoplankton samples were preserved in 2% (final concentration) neutralized formaldehyde and analyzed following the Utermol method (2) on Zeiss Axiovert 200 inverted microscope. For statistical analysis the software packages Systat 12 and Primer 6 were used.

Results and discussion
A total of 237 species were recorded. There were 126 species of Bacillariophyceae, 83 Dinophyceae, 13 Haptophyta and 5 species of Crysophyta while nanoplankton fraction was divided in 10 distinct groups (diatomeae, dinoflagelata, cryptophyta, chlorophyta, cocolitophoridae..). Statistical analysis of the phytoplankton community structure showed that the stations along the western Istrian coast were significantly different from the stations along the eastern Istrian cost and in Kvarner Bay (Fig.2). The nanophytoplankton component was the dominant plankton guild throughout the whole year in the NA while the microphytoplankton (size >20 µm) was restricted to sporadic (late spring and autumn) blooms. During the investigated period the most prominent bloom event was the autumn bloom (October 2007, September 2008) characterized mostly by diatoms. The phytoplankton community during the bloom was dominated by *Chaetoceros* species and *Pseudonitzschia* species which were pronounced especially along the Western Istrian stations (4.2 x10 ^{5} cell/l Fig.2.). The peak cell abundance of the spring/summer bloom was recorded in June in the surface layer of Rijeka Bay where *Skeletonema spp*. reached 3.6 x10 ^{5} cell/l, while the deeper water layers were dominated by Coccolitophoridae like *Emiliana huxleii* (1.1 x10 ^{5} cell/l). The Rijeka Bay can be described as mainly influenced by the harbour city of Rijeka and the karstic Rjecina river, where the nutrient rich fresh water input triggered the *Skeletonema* sp. bloom only in this restricted region. Phytoplankton community structure alowed to discriminate different regions along the NA cost.

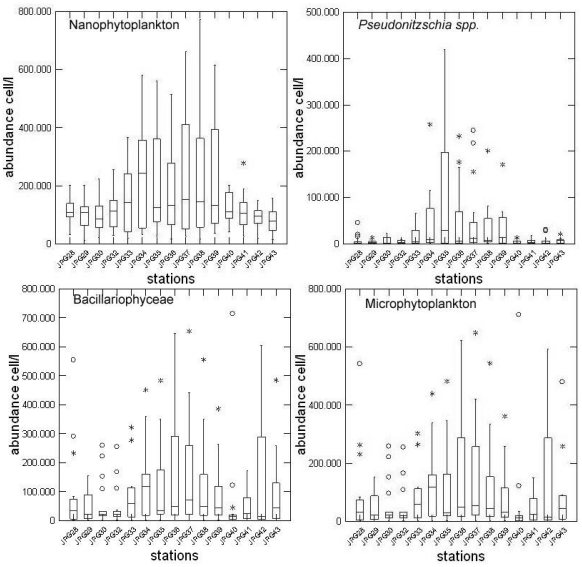


Fig. 2. Abundances of main phytoplankton groups and *Pseudonitzschia spp.* with the distribution over the stations

References
1 - Parsons, T.R., Maita Y., Lalli C.M., 1984: A manual of chemical and biological methods for seawater analysis. Pergamon Press, Toronto
2 - Utermöhl, H., 1958: Zur Vervollkommnung der quantitativen Phytoplankton Methodik. Mitteilungen Internationale Vereiningung fuer Theoretische und Angewandte Limnologie 9, 1–38.

HOLOCENE SEA-LEVEL CHANGE IN THE MEDITERRANEAN SEA: QUANTITATIVE RECONSTRUCTIONS BASED ON FORAMINIFERAL TRANSFER FUNCTIONS

Yvonne Milker [1]*, Gerhard Schmiedl [1] and Christian Betzler [1]
[1] University of Hamburg, 20148, Germany - Yvonne.Milker@uni-hamburg.de

Abstract
Results from Late Glacial and Holocene relative sea-level estimates in shelf carbonate environments of the Western Mediterranean Sea based on various regression methods and, on Plankton/ Benthos ratios, are presented. The relative sea-level estimations for the different regions are similar to the global sea-level history underlying the potential of benthic foraminifera for quantitative sea-level reconstructions.
Keywords: Western Mediterranean, Sea Level, Foraminifera

Introduction
Quantitative sea-level reconstructions using planktonic and benthic foraminifera were more applied in the recent past and, give a potential for paleo-sea level reconstructions over various timescales or for climate modeling.

Methods
The sea level estimations were based on various regression methods such as Weighted Averaging (WA), Partial Least Squares (PLS) and, a combination of both. Further, Modern Analoque Technique (MAT) and, a method based on Plankton/ Benthos ratios were used. The transfer functions generated from recent benthic foraminiferal assemblages in surface samples were applied on fossil data-sets from the Alboran Platform, the Oran Bight and the Mallorca shelf (cores 342-1, 367-1 and 401-1).

Results
The best predictive potential is given for the WA-PLS method. The relative sea-levels estimates are similar to the global sea-level history on the Alboran Platform and off the Mallorca Shelf (Fig. 1). In the Oran Bight, our estimates show also a sea-level rise for the past 6000 cal. years BP, but exhibit significant deviation from the global trend likely attributed to age model uncertainties. The sea-level estimates based on transfer functions generated from recent P/B ratios show in generally the global sea-level development, but with a higher inaccuracy. Species-environment relations were investigated, showing that on the Mallorca Shelf substrate and food effects interfere with the sea level signal resulting in an partly overestimation of paleo-water depths.

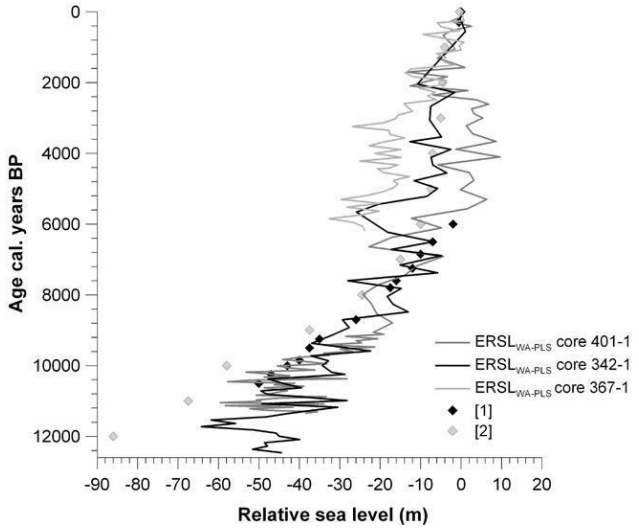


Fig. 1. The relative sea-levels estimates are similar to the global sea-level history on the Alboran Platform and off the Mallorca Shelf

References
1 - Bard, E., Hamelin, B., Arnold, M., Montaggioni, L., Cabioch, G., Faure, G., Rougerie, F., 1996. Deglacial sea-level record from Tahiti corals and the timing of global meltwater discharge. *Nature* 382: 241-244.
2 - Fairbanks, R. G., 1989. A 17,000-year glacio-eustatic sea level record: influence of glacial melting rates on the Younger Dryas event and deep-ocean circulation. *Nature* 342: 637-642.

MOLECULAR MODELING IN BLUE BIOTECHNOLOGY: A COST-EFFECTIVE AND SUSTAINABLE APPROACH TO EXPLOIT MEDITERRANEAN CHEMICAL DIVERSITY

Ernesto Mollo [1]* and Pietro Amodeo [1]
[1] CNR - Institute of Biomolecular Chemistry, 80078 Pozzuoli NA Campania, Italy - ernesto.mollo@icb.cnr.it

Abstract
Within this study, metabolites isolated from marine organisms living in the MediterraneanSea have been investigated by both a chemo-ecological and a computational approach to decode the "information content" of marine natural products in terms of possible biotechnological applications. This led us to predict, from 3D chemical structures, the interaction of selected metabolites with macromolecular targets underlying crucial ecological and pharmacological actions.
Keywords: Biotechnologies, Alien species

Natural products possess an extraordinary pharmacological effectiveness and specificity compared to artificially designed molecules because evolutionary selection has been the "nature's own high-throughput screening" process for the optimization of biologically active compounds [1, 2]. As a result, a broad range of bioactivities has been found within the increasing number of novel secondary metabolites isolated from the under-explored marine sources [3]. However, similarly to their terrestrial counterparts, marine natural products often interact with more than one specific target, also producing toxicity and other side effects which often prevent their use as drugs. By combining a chemo-ecological approach in the study of the natural function of small molecules isolated from Mediterranean flora and fauna with modern "in silico" target fishing techniques, we propose an efficient method for "a priori" predictions of possible exploitation of marine natural products, or their analogues, in biotechnological fields. Selected cases will be presented, with emphasis on possible uses in biotechnology of undesired biomaterials from invasive alien species, which are altering the Mediterranean community structure [4]. This research has led us to select promising candidates in drug discovery, and to design structural analogues for lead optimization. We believe that our approach to blue biotechnology should prevent the negative impacts of dispersive pharmacological evaluations and randomly-guided sampling activities on the Mediterranean ecosystem, also providing sustainable opportunities for the sea-based economy of coastal communities.

References
1 - Paterson I. and Anderson E.A., 2005. The renaissance of natural products as drug candidates. *Science,* 310: 451-453

2 - Clardy J. and Walsh C., 2004. Lessons from natural molecules. *Nature,* 432: 829-837.

3 - Donia M. and Hamman M.T., 2003. Marine natural products and their potential applications as anti-infective agents. *Lancet Infect. Dis.,* 3: 338-48.

4 - Mollo E., Gavagnin M., Carbone M., Castelluccio F., Pozone F., Roussis V., Templado J., Ghiselin M.T. and Cimino G., 2008. Factors promoting marine invasions: A chemoecological approach. *Proc. Natl. Acad. Sci. USA,* 105: 4582-4586.

CNIDARIA SHARE HOMOLOGOUS SECRETED PHOSPHOLIPASES A_2 WITH BACTERIA AND FUNGI

Timo Nevalainen [1]*

[1] Department of Pathology, University of Turku, Finlande - timneva@utu.fi

Abstract

Secreted phospholipases A_2 ($sPLA_2$) containing conserved domain pfam09056 Phospholip_A2_3: Prokaryotic PLA_2 are present in bacteria and fungi. In the current study, prokaryote-type $sPLA_2$s were identified also in eumetazoans of the Phylum Cnidaria, such as sea anemone *Nematostella vectensis*, hydroid *Hydra magnipaillata* and hard coral *Acropora millepora*. The functions of cnidarian prokaryote-type $sPLA_2$S are unknown.

Keywords: Bacteria, Cnidaria, Enzymes, Symbiosis

Introduction

Phospholipases A_2 comprise a large family of intracellular and secreted enzymes. Secreted PLA_2s participate in important physiological and pathological functions, such as digestion of dietary phospholipids, inflammatory reaction and antimicrobial defence against bacteria and other pathogens. Conserved domain pfam09056 Phospholip_A2_3: Prokaryotic PLA_2 [1] is characteristic of a number of $sPLA_2$s of both Gram positive and Gram negative bacteria. The catalytic site motif of prokaryote-type PLA_2 (XCXXHDXX) contains the conserved histidine and aspartic acid residues typical of $sPLA_2$s. In addition to bacteria, prokaryote-type $sPLA_2$s have been identified in fungi. The observations reported here indicate that prokaryote-type $sPLA_2$ is present also in eumetazoan organisms of the Phylum Cnidaria.

Material and methods

Conserved domain pfam09056 was identified at web site http://www.ncbi.nlm.nih.gov/Structure/cdd/wrpsb.cgi in PLA_2 sequences retrieved at NCBI and Swiss-Prot databases at web sites http://blast.ncbi.nlm.nih.gov/Blast.cgi and http://www.expasy.ch/sprot/, respectively. Multiple sequence alignment was done by the program CLUSTAL W2 at http://www.ebi.ac.uk/Tools/clustalw2/index.html.

Results and discussion

The genome of starlet sea anemone *Nematostella vectensis* (Cnidaria, Anthozoa) [2] contains a rich selection of PLA_2s [3] including prokaryote-type $sPLA_2$s. In addition to fungi, cnidaria are the only eukaryotes that contain prokaryote-type sPLA2s. The current observations show that there are in *Nematostella vectensis* distinct sPLA2s that contain the conserved domain pfam09056 Phospholip_A2_3: prokaryotic PLA_2. In other cnidaria including hydroid *Hydra magnipapillata* and hard coral *Acropora millepora* there are $sPLA_2$s homologous to prokaryote-type $sPLA_2$. The presence of prokaryote-type PLA_2s in cnidaria seems to be unique; PLA_2s containing the conserved domain pfam09056 Phospholip_A2_3: prokaryotic PLA_2 were not found in any other metazoan (or eukaryote) besides fungi in the current study. The function and evolutionary origin of prokaryote-type PLA_2 in cnidaria is unknown. Besides vertical inheritance, horizontal gene transfer should be considered as a possibility. A further explanation for finding DNA sequences of prokaryote-type PLA_2 in cnidaria would be the presence of bacteria (or fungi) in these marine invertebrates, either as symbionts, commensals, pathogens or inert contaminants. However, the latter alternatives seem unlikely, since measures were taken to exclude contamination of the specimens used for sequencing the genome of *Nematostella vectensis* (Putnam et al. 2007).

References

1 - Finn R.D., Tate J., Mistry J., Coggill P.C., Sammut S.J., Hotz H.R., Ceric G., Forslund K., Eddy S.R., Sonnhammer E.L.L., Bateman A., 2008. The pfam protein families database. *Nucleic Acid Res.*, 36: D281-D288.

2 - Putnam N.H., Srivastava M., Hellsten U., Dirks B., Chapman J., Salamov A., Terry A., Shapiro H., Lindquist E., Kapitonov V.V., Jurka J., Genikhovich G., Grigoriev I.V., Lucas S.M., Steele R.E., Finnerty J.R., Technau U., Martindale M.Q., Rokhsar D.S., 2007. Sea anemone genome reveals ancestral eumetazoan gene repertoire and genomic organization. *Science*, 317: 86-94.

3 - Nevalainen T.J., 2008. Phospholipase A_2 in the genome of Nematostella vectensis. *Comp. Biochem. Physiol. D Genom. Proteom.*, 3: 226-233.

PATTERNS OF BACTERIOPLANKTON DIVERSITY IN RECREATIONAL MARINAS IN THE ISLAND OF MALLORCA (BALEARIC ISLANDS) AND ITS RELATION TO HYDROCARBON POLLUTION

B. Nogales [1]*, M. P. Lanfranconi [1], J. Piña-Villalonga [1], L. Y. Suárez-Suárez [1] and R. Bosch [1]
[1] Dept. Biologia, Universitat de les Illes Balears, Palma de Mallorca, Spain - bnogales@uib.es

Abstract
The analysis of bacterioplankton in surface seawater from different recreational marinas evidenced common patterns in the diversity of some bacterial groups, i.e. *Alphaproteobacteria*. In particular, certain phylotypes of the *Roseobacter* clade predominated in these environments. Although this clade seemed to be stimulated by experimental diesel-oil pollution, their apparent success in polluted environments, such as marinas, is most likely due to a combination of factors and not only to hydrocarbon pollution.
Keywords: Bacteria, Balear Islands, Biodiversity, Pollution, Coastal Waters

Studies on bacterioplankton diversity in man-made, artificial habitats, such as ports and marinas are scarce (1-3). Besides, we do not know which are the key factors determining changes in bacterioplankton diversity in areas adjacent to ports (2), nor the importance that these changes might have in the overall functionality of the coastal ecosystem. The increasing pressure of nautical tourism justifies the importance of improving our knowledge about the microbiota of these environments. Preliminary studies done by our group in Mallorca (Balearic Islands) indicated that there might be common patterns in the bacterioplankton diversity in recreational marinas. Therefore, our first aim was to demonstrate that such patterns in diversity really existed. We also hypothesised that at least some of the components of the bacterioplankton in marinas were selected by the stress caused by hydrocarbon pollution and we made two laboratory experiments to address this issue.

Surface water samples from seven marinas around the Island of Mallorca were taken from the shore throughout a year period (2008-2009). For molecular characterisation of diversity, DNA was extracted from 0.22 µm filters through which 2 litres of pre-filtered water (5 µm) was filtered. Bacterial diversity studies were based on terminal restriction fragment length polymorphism analysis (T-RFLP) of 16S rRNA genes with primers for *Bacteria* and for *Alphaproteobacteria*, and by the generation of clone libraries as described previously (2-3). For the experimental pollution experiments, surface water samples from a pristine coastal location (39º29'05"N, 2º28'16"E) were taken at two time points, late winter and summer 2007. Each time, four laboratory microcosms were prepared (45 l of water): two controls and two treated with low concentrations (30 mg l^{-1}) of diesel oil. Diversity analysis was based in the amplification of ribosomal RNA by reverse transcription and PCR (RT-PCR). Changes in diversity were followed for a period of 89 h.

Our study in surface water from different recreational marinas confirmed that there were common trends in the composition of bacterial communities. Fig. 1 shows a non-metric multidimensional plot representing the similarity of T-RFLP profiles for *Alphaproteobacteria* obtained for the different marinas. Different marinas harboured similar alphaproteobacterial populations.

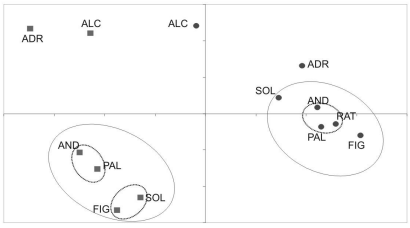


Fig. 1. NMDS plot of the similarities of T-RFLP profiles for 16S rDNA of *Alphaproteobacteria* from different recreational marinas in Mallorca Island. Marinas are identified by a three-letter code. Sampling data: September 2008, squares; March 2009, circles. Solid lines encircle profiles with similarities >70% (Bray-Curtis coefficient) and dashed lines those with similarities >80%. Stress value, 0.108

We also observed a temporal dynamics in the diversity of these populations; samples from different times separated well in relation to the vertical axis, and the dynamics were the same in different marinas. There were phylotypes, (defined at 99% sequence similarity cut-off), particularly in the *Roseobacter* clade of the *Alphaproteobacteria*, which predominated in all the marinas. In the pristine waters used for microcosm experiments the *Roseobacter* clade constituted a minor component of the bacterioplankton. However, this group increased in abundance in response to diesel addition, and contributed, among others, to the rapid changes (within hours) in bacterial composition observed after diesel addition (Fig. 2), particularly in summer. Although we have evidences that some isolates of this group can grow on hydrocarbons we think that their apparent success as main components of the bacterioplankton of recreational marinas is the result of a combination of factors, and not only to hydrocarbon pollution.

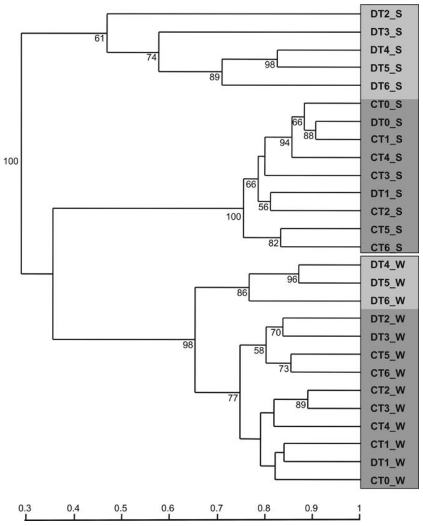


Fig. 2. UPGMA dendrogram of the T-RFLP profiles for metabolically-active bacterioplankton (16S rRNA) in control (label C) and diesel-treated microcosms (label D). Winter samples, W; summer samples, S. Sampling times are: T0, 0h; T1, 3h; T2, 17h; T3, 27h; T4, 41h; T5, 65h and T6, 89h. Numbers next to the nodes correspond to Bootstrap values (1000 replicates) >50%. Scale bar represents similarity (Bray-Curtis coefficient)

Acknowledgements - Funds were obtained from project CTM2008-02574/MAR from the Spanish Ministry for Science and Innovation (MICINN). MPL and JMP-V have PhD fellowships from MICINN. LYS-S has a PhD fellowship from Banco de Santander

References
1 - Denaro R., D'Auria G., Di Marco G., Genovese M., Troussellier M., Yakimov M.M. and Giuliano L., 2005. Assessing terminal restriction fragment length polymorphism suitability for the description of bacterial community structure and dynamics in hydrocarbon-polluted marine environments. *Environ Microbiol* 7:78–87.
2 - Nogales B., Aguilo-Ferretjans M.M., Martin-Cardona C., Lalucat J. and Bosch R., 2007. Bacterial diversity, composition and dynamics in and around recreational coastal areas, *Environ. Microbiol*. 9: 1913–1929.
3 - Aguiló-Ferretjans M.M., Bosch R., Martín-Cardona C., Lalucat J. and Nogales B., 2008. Phylogenetic analysis of the composition of bacterial communities in human-exploited coastal environments from Mallorca Island (Spain). *Syst. Appl. Microbiol*. 31:231–240

LEPTOLYNGBYA SPECIES ISOLATED FROM THE SPONGE *PETROSIA FICIFORMIS* AS POTENTIAL SOURCE OF NOVEL COMPOUNDS

Patrizia Pagliara [1] and Carmela Caroppo [2]*
[1] Institute for Coastal Marine Environment, National Research Council - carmela.caroppo@iamc.cnr.it
[2] DiSTeBA - University of Salento

Abstract
A cyanobacterial species belonging to *Leptolyngbya*genus has been isolated from the marine sponge *Petrosia ficiformis* and cultured in laboratory conditions. Aqueous extracts from this *Leptolyngbya* strainshowed a biological activity, influencing *Artemia salina* vitality, being cytotoxic with human erythrocytes and interfering with the sea urchin development.
Keywords: Cyanobacteria, Biotechnologies, Porifera

Introduction
Cyanobacteria are important primary producers of the marine and freshwater environments. But they have also been identified as one of the most promising groups of organisms producing novel, bioactive, natural compounds [1, 2]. Indeed, many investigations in this field indicated that marine microorganisms are substantially involved in the biosynthesis of marine natural products isolated from macroorganisms such as invertebrates. [3, 4]. The chemical structures of over 13,000 novel compounds from marine organisms has been already determined and their potential use in pharmaceutics widely considered [5]. Antibacterial, antiviral, antifungal, algicide and cytotoxic activities have been reported by many authors [6, 7, 8, 9].

Material and Methods
One strain of *Leptolyngbya* wasisolated from *Petrosia ficiformis* and cultured in laboratory conditions.The extracts were obtained after sonication and centrifugation of cyanobacterial cells. *Artemia* nauplii, human red blood cells and sea urchin gametes and embryos were exposed to the cyanobacterial extracts under controlled conditions, then examined for lethal (mortality) and sub-lethal effects.

Results and discussions
Aqueous extracts from *Leptolyngbya* sp. isolated from the Mediterranean sponge *Petrosia ficiformis* were able to exert a biological activity. The extracts influenced the vitality of *Artemia salina* nauplii, induced the human erythrocytes lysis and interfered with the normal development of sea urchin. In particular, the presence of the extract induced a 90% of nauplii mortality after 24hrs of contact at the concentration of 15 mg/ml (w/v) and 100% of mortality at the concentration of up 0.9 mg/ml (w/v) after 48 hrs of contact. The ability to disrupt the integrity of erythrocytes was weak, inducing only 10% of haemolysis, but a strong activity was detectable against sea urchin embryos. In particular, the segmentation process was inhibited after treatment of eggs and embryos with *Leptolyngbya* sp. extract. While male and female gametes were able to perform the fertilization process, the resulting embryos were unable to correctly develop to the pluteus larva. In conclusion, this cyanobacterial species may be regarded as good candidate for drug discovery, with applications especially in pharmaceuticals as inhibitor of cell division, also if further investigations will be necessary to better clarify its biological activity.

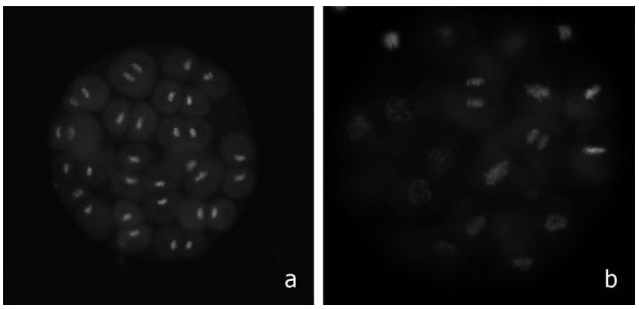


Fig. 1. Sea urchin embryos: a) control and b) embryo developed in presence of the *Leptolyngbya* sp. extract: note the asynchronous cells division

References
1 - Sivonen K. and Börner T., 2008. Bioactive compounds produced by cyanobacteria. *In*: Herraro A. and Flores E. (eds.), The cyanobacteria: Molecular Biology, Genomics and Evolution. Caister Academic Press, Norfolk, U. K., pp. 159-197.
2 - Moore R.E., Patterson G.M.L. and. Carmichael W.W., 1988. New Pharmaceuticals From Cultured Blue-Green Algae. *In*: Fautin D.G.(ed.), Biomedical Importance of Marine Organisms. Memoirs of the Californian Academy of Science, Californian Academy of Science, San Francisco, CA, Vol. 13, pp. 143–150.
3 - Sone H., Kondo T., Kiryu M., Ishiwata H., Ojika M. and Yamada K., 1995. Dolabellin, a cytotoxic bisthiazole metabolite from the sea hare *Dolabella auricularia*: structural determination and synthesis *J. Org. Chem.*, **60:** 4774-4781.
4 - Nakao Y., Yoshida W.Y., Szabo C.M., Baker B.J. and Scheuer P.J., 1998. More peptides and other diverse constituents of the marine mollusk *Philinopsis speciosa. J. Org. Chem.*, **63**: 3272-3280.
5 - Fenical W.,1997. New pharmaceuticals from marine organisms. *Mar. Biotechnol.*, 15: 339-341.
6 - Rao C.S.V.R., 1994. Antimicrobial activity of cyanobacteria. I. J. Mar. Scien., 23: 55-56.
7 - McDermott C.M., 1998. The cyanobacterial toxin, Microcystin-LR, can induce apoptosis in a variety of cell types. Toxicon**,** 36: 1981-1996.
8 - Schlegel I., 1999. Antibiotic activity of new cyanobacterial isolates from Australia and Asia against green algae and cyanobacteria. J. Appl. Phycol.,10: 471-479.
9 - Schaeffer D.J., 2000. Anti-HIV activity of extracts and compounds from algae and cyanobacteria. Ecotoxicol. Environ. Saf., 45: 208-227.

RAPID ENZYMATIC METHOD FOR THE ENUMERATION OF FAECAL BACTERIA (*ENTEROCOCCI)* IN BATHING SEAWATER

Marion Peirache [1]*, Stephane Mounier [1], Nathalie Patel [1] and Yvan Martin [2]
[1] Laboratoire PROTEE, 83957 La Garde, France - marion-peirache@etud.univ-tln.fr
[2] Institut Oceanographique Paul Ricard, Île des Embiez - Le Brusc

Abstract
The bathing water monitoring has a great interest for both bathers and authorities. The European community has actually lowered the suitable tolerance levels of the two major fecal indicators: *Escherichia coli* and *Enterococci*. The enzymatic assay enables the microbiological quality evaluation in less than an hour. Now available for *Escherichia coli*, this method doesn't work for *Enterococci* yet. Our present work first of all aims at adapting this method for *Enterococci* and in a second time at explaining biotic and abiotic discrepancies met during on site application.
Keywords: Beach, Bacteria, Pollution, Monitoring

Since the new requirements of the European Community (Directive 2006/CE 07), rules have changed and the bathing water quality monitoring has to be improved. The challenge is to combine rapidity and sensitivity with faster techniques than those currently available, allowing real-time results. Such kinds of methods are relevant for a good beaches management, since public health and economic issues are concerned.
The rapid enzymatic detection method is able to produce a fast result, but may be disturbed by interference. The principle of this technique, developed for *Escherichia coli* [1], is to filter a defined volume of sea water through a membrane (0.22 µm) which retains bacteria. Then, the membrane (*i.e.* bacteria) is submitted to a specific substrate enriched with a fluorescent compound, Methylumbelliferone (MUF). The more bacteria are present in the sample, the faster is the lysis of the substrate. The kinetic of the fluorescence apparition during 30 minutes gives a straight line which slope is proportional to enzymatic activity. This slope is correlated to the enumeration of bacteria by standard methods (membrane filtration and/or microplate) giving the number of bacteria in function of enzymatic activity.

To explain discrepancies (figure 1), this work first establish the original response for *Enterococci* by working on pure strain of bacteria, then test different parameters, biotic or abiotic ones, on the enzymatic response.

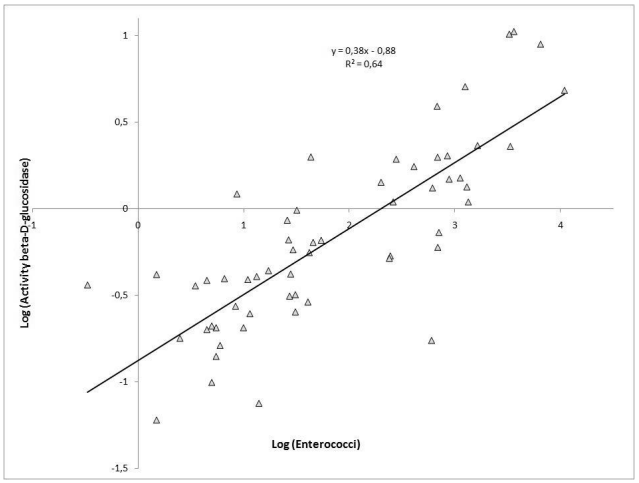


Fig. 1. Log-log linear regression between β-D-glucosidase activity (ng MUF/ mL) and *Enterococci* enumerated by standard method (CFU/100mL) *N=58*

The presence of micro-organisms, of plankton or suspended matter in natural samples can actually induce both biotic and physical interferences. Biotic interferences are confirmed, as previously found in literature for *Escherichia coli* [2] : some phytoplankton organisms are able to degrade the substrate. In the same way, autochthonous bacteria (*Vibrio* spp.) enhance the enzymatic activity. Suspended matter can moreover lead to an underestimation of bacteria numeration : a phenomenon of adsorption may occur, depriving contact of bacteria with substrate. Futhermore organic matter could have influence as its natural fluorescence wavelengths are located around the MUF ones (figure 2).

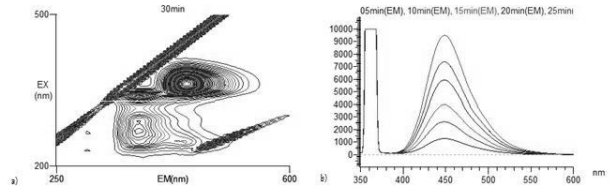


Fig. 2. A) The 3D spectral representation of the fluorescence of the MUF (λ_{ex}= 362 nm; λ_{em}= 445 nm) and natural fluorescence of bacteria at the end of measure (T=30 minutes).The biggest peak (MUF) is over the characteristic peak C (visible humic-like). b) The degradation of the substrate is showed towards the 2D curves of fluorescence of released MUF every 5 minutes along the kinetic (λ_{em}= 445 nm)

The first results of this work is the optimal conditions (pH, temperature, MUF concentration, ...) for enzymatic response of Enterococci (6 strains) found by simplex optimization design.

The second result is obtain by chemometric experimentation on both Enterococci and *Escherichia coli* (3 strains). Coefficient of factorial analysis for 7 parameters (suspended matter, hydrophobic and hydrophilic organic matter, phytoplankton, autochtonous bacteria, heavy metals). are extracted giving the impact of each parameter on the method efficiency.

References
1 - Tryland, I. and Fiksdal, L., 1998., Enzyme characteristics of ß-D-galactosidase and ß-D-glucuronidase-positive bacteria and their interference in rapid methods for detection of waterborne Coliforms and *Escherichia coli*. *Appl. Environ. Microbiol*. 64(3): 1018-1023.
2 - Caruso, G., Monticelli L. S., et al., 2008. Development of a fluorescent antibody method for the detection of *Enterococcus faecium* and its potential for coastal aquatic environment monitoring. *Mar. Pollut. Bull.* 56(2): 318-324.

SPATIAL VARIABILITY OF PLANKTON COMMUNITIES IN A SEMI-CLOSED DISTURBED MEDITERRANEAN ECOSYSTEM (TOULON BAY, FRANCE)

S. Personnic [1], J. L. Jamet [1], G. Durrieu [1], D. Jamet [1], N. Jean [1], H. Zhao [1], E. Tessier [1], N. Patel [1], B. Poste [1], C. Le Poupon [1] and C. Garnier [1]*

[1] Laboratoire PROTEE, Université du Sud Toulon Var, BP20132 83957 La Garde, France - cgarnier@univ-tln.fr

Abstract

Plankton and chemical composition of seawater have been studied along a transect of thirteen sampling stations in Toulon Bay during June 2009. Toulon Bay, located in the northwest Mediterranean coast of France, hosts major commercial and navy harbours. According to location of the sampling stations, this bay is variably affected by anthropogenic inputs, raw sewage from the Toulon area and maritime traffic. To understand spatial variability of the plankton communities in this disturbed ecosystem (little and large bay), measurements of physical and chemical parameters were carried out in the water column of Toulon Bay. According to all parameters analysed, several patterns have been obtained to explain the spatial variability of the plankton communities in this ecosystem.

Keywords: Plankton, Coastal Waters, Metals, Organic Matter, Bacteria

Experimental

Samplings were carried out the 11 June 2009 at thirteen stations, chosen strategically to be representative of the entire Bay and clearly separated from the open sea (Fig. 1). Samples for chemical analysis were collected in 1-L Teflon (Nalgene) bottles by scuba diving at 3-m depth, microbial and larger photosynthetic cells with a Niskin 10L-sampling bottle at 3-m depth and zooplankton samples were collected with a plankton net (0.5 mouth diameter, 2.5 m long, 90 µm mesh size) along the 0 to 5-m depth water column. Additionally, at 2 stations (in each part of the Toulon Bay), water sampling were performed at 1, 3 and 5-m of depth to investigate the vertical variability of the measured parameters.

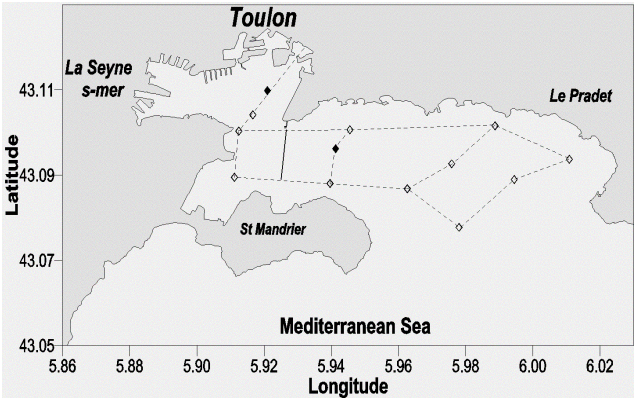


Fig. 1. Location of the sampling points (open diamond: 3-m depth sampling: black diamond: 1, 3 and 5-m depth sampling)

Physico-chemical parameters (temperature, salinity, pH, O_2, Eh, turbidity) were measured in-situ using a multiprobe (Hydrolab MiniSonde 4a). Microbial communities (heterotrophic bacteria, cyanobacteria and autotrophic pico eukaryotes) were counted by flow cytometry [1]. Larger phytoplankton cells were enumerated by inverted microscopy [2]. Zooplankton was characterized by microscopy and proteomics identification (Electrophoresis analysis). After filtration on 0.2µm on line filters (Sartorius) chemical samples were studied to (1) characterize the dissolved organic matter (DOM) by TOC-meter (TOC-V, Shimadzu) and 3-D fluorescence spectroscopy (Hitachi F-4500) measurements, and (2) analyse the total dissolved Cu, Cd, Pb ,Zn (by DPASV), total dissolved Hg (by CV-AFS) orthophosphates and nitrates (by colorimetric technique) concentrations.

Results and Discussion

According to the location of the sampling stations [3], major changes in plankton abundances and diversities have been recorded [4]. As a result, cell abundances (*e.g.* heterotrophic bacteria, *Prochlorococcus* sp.) have been multiplied by a factor 2 between the Large Bay and the Little Bay. However, diversity of large phytoplankton cells and of zooplankton declined from the Large to the Little Bay. By localisation, several patterns have been established to determine "explicative variables" of these spatial variations. The results provide a new evidence of the critical role played by anthropogenic inputs in the spatial distribution of the "global" plankton cells (*i.e.* microbial and larger cells) and highlights the importance to consider further the chemical composition of the water column for a better understanding of the plankton ecology.

References

1 - Marie, D., Partensky, F., Vaulot, D., Brussaard, C.P.D., 1999. Enumeration of phytoplankton, bacteria and viruses in marine samples. *Current Protocols In Cytometry*, 11.11.11-11.11.15.

2 - Dodson, A.N., Thomas, W.H., 1964. Concentrating plankton in a gentle fashion. *Limnol. oceano*. 9: 455-456

3 - Rossi, N., Jamet, J.-L., 2008. In situ heavy metals (copper, lead and cadmium) in different plankton compartments and suspended particulate matter in two coupled Mediterranean ecosystems (Toulon Bay, France). *Mar. Pollut. Bull.*, 56: 1862-1870.

4 - Martin, E.S., Harris, R.P., Irigoien, X., 2006. Latitudinal variation in plankton size spectra in the Atlantic Ocean. *Deep-Sea Res. II*, 53:1560–1572.

ENUMERATION OF FECAL INDICATOR BACTERIA, IN CALVI BAY (CORSICA)

Stephanie Polain [1]*, Vincent Demoulin [2] and Mathieu Poulicek [1]
[1] University of Liège, Laboratory of Animal Ecology and Ecotoxicology - Unit of Marine Ecology, 4020, Belgique - S.Polain@ulg.ac.be
[2] University of Liège, Laboratory of Algology, Mycology and Experimental Systematic, Belgique

Abstract
Man-induced pressures are very important on Mediterranean ecosystems. In order to check the accuracy of the use of faecal bacteria as indicator of anthropic contamination, we assessed them in contaminated and uncontaminated areas of the Calvi Bay (Corsica, France).
Keywords: Bacteria, Western Mediterranean, Sewage Pollution

Introduction - More than 70% of the world's human population lives in watersheds that drain to the coast. Further population growth will be centered in these regions, exerting unprecedented pressure on riverine, estuarine and coastal habitats receiving human pollutants [1]. The Mediterranean Sea is not an exception. Considering its high species diversity and endemism rate, it is one of the richest marine regions of Europe [2]. However, this unit is ecologically vulnerable due to man-induced pressures. Therefore, it is important to check the accuracy of existing methods and to develop new ones more effective to study and counteract man-induced loss of aquatic ecosystem biodiversity, water quality and recreational resources. In this context, microbial bioindicators play a major role in detecting and characterizing these changes. Indeed, microorganisms are generally highly sensitive to and heavily affected by environmental perturbations. They have fast growth rates, and respond to low levels of pollutants as well as other physical, chemical, and biotic environmental changes [3]. Among them, faecal bacteria are used worldwide as indicator of water anthropic contamination, they are used to assess the potential health risk of pathogenic organisms presence in recreational and aquacultural waters [4]. Faecal coliform and faecal Enterococci are recommended by the European Union and the US Environmental Protection Agency (EPA) because they are found specifically in warm-blooded animal faeces [5] and not present in non polluted sites.

Material and methods - The bacterial community was studied at two sites of the Calvi Bay, in Corsica (France); at the sewer in the port of the Station de Recherches Sous-marines et Océanographiques (STARESO) and 30m outside STARESO's port, on a patch of sand considered clean and unaltered by the sewage. Samples were collected at different depth and four times a year (April, May, July and November 2009*). Different methods were used; epifluorescence with acridine orange staining to enumerate the total bacteria, and 3M™ Petrifilm™ for aerobic mesophilic flora, Enterobacteriaceae, Coliforms and *Escherichia coli*.

Results and discussion - In July, total bacteria number at the sea surface level of the sewer (Fig. 1-A) was twofold higher ($4.10^5 \pm 3{,}1.10^4$ Bacteria/ml) than in April ($2.10^5 \pm 1{,}4.10^4$ Bacteria/ml) and was more constant at the bottom level (Fig. 1-B), with values comprised between $7{,}2.10^4$ and $1{,}2.10^5$ bacteria per ml throughout the sampling campaign. Comparatively, results were less variable and bacteria are less abundant (Fig. 1-B) on the patch sand, except in April in the *Posidonia* matte, where there were $4{,}2.10^5 \pm 1{,}5.10^5$ Bacteria/ml.

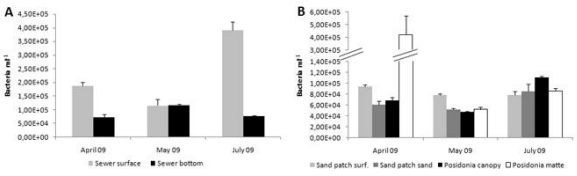


Fig. 1. Variation of bacteria number per ml at the sewer (A) and at the patch sand (B) counted by epifluorescence with acridin orange staining (mean ± SD).

3M™ Petrifilm™ analysis (Fig. 2) showed that there were fewer bacteria identified in April comparatively to May and July. This could be explained by the low presence of scientists and tourists in the station during this period. We can also observe that the abundance of aerobic mesophilic bacteria was still more marked at the sewer (Fig. 2-A and B) than at the patch of sand (Fig. 2-C,D,F and E) for all sampling periods. This difference was also highlighted by the presence of a greater number of Enterobacteriaceae, Coliforms and *Escherichia coli*. Surprisingly, these bacteria were also found in smaller number in the matte and in the canopy of *Posidonia oceanica* meadow next to the sand patch. These biota may be more conducive to abundance by protecting against predators, increasing nutrient and organic carbon availability and providing colonisable surfaces than in the water column [6].

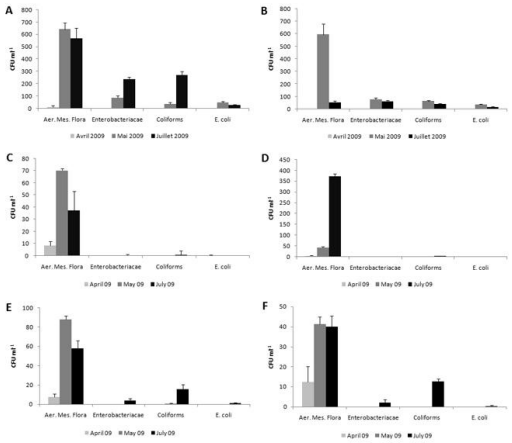


Fig. 2. Variation of aerobic mesophilic flora, Enterobacteriaceae, Coliforms and *Escherichia coli* CFU per ml at the sewer surface (A) and bottom (B) and at the patch sand surface (C), bottom (D), *Posidonia* canopy (E) and *Posidonia* matte (F) with 3M Petrifilm test (mean ± SD).

Conclusions - These preliminary results show the applicability of 3M™ Petrifilm™ for analysis of marine samples. Nevertheless, further analyses have to be done to check the accuracy of this product. Moreover, it seems that some faecal bacteria are able to survive in *Posidonia* meadow. Therefore, new bioindicators must be developed to detect water anthropic contamination. In this context, *Bangiophyceae* could be a potential candidate.

Acknowledgement This study was supported by the FRIA of Belgium and by RACE (ACR n°05/10-33). The authors tanks 3M™ Petrifilm™ and all the staff from STARESO. *Data from November 2009 are under sampling and analysing, the results will be added later for the conference.

References
1 - Vitousek, P.M., Mooney, H.A., Lubchenko, J., ad Mellilo, J.M., 1997. Human domination of Earth's ecosystem. *Science*, 277: 494-499.
2 - Bianchi, C. N. and Morri, C., 2000. Marine biodiversity of the Mediterranean Sea: Situation, problems and prospects for future research. *Marine Pollution Bulletin*, 40 (5): 367-376.
3 - Paerl, H.W., Dyble, J., Moisander, P.H., Noble, R.T., Piehler, M.F., Pinckney, J.L., Steppe, T.F., Twomey, L. and Valdes, L.M., 2003. Microbial indicators of aquatic ecosystem change: current applications to eutrophication studies. FEMS *Microbiology Ecology*, 46: 233-246.
4 - Dadswell, J.V., 1993. Microbiological quality of coastal waters and its health effects. *Intern. Jour. of Environmental Health Research*, 3: 32-46.
5 - U.S. Environmental Protection Agency. Ambient water quality criteria for bacteria. EPA A440/5-84-002. Washington, DC: U.S. Environmental Protection Agency, 1986.
6 - Lee, C.M., Lin, T.Y., Lin, C-C., Kohbodi, G.A., Bhatt, A., Lee, R. and Jay, J.A., 2006. Persistence of fecal indicator bacteria in Santa Monica Bay beach sediments. *Water Research*, 40: 2593 - 2602.

ANALYSIS OF LIPID CLASSES AND FATTY ACID COMPOSITION IN MUSCLE OF THE GREY MULLET *CHELON LABROSUS* LIVING IN TUNISIAN GEOTHERMAL WATER

I. Rabeh [1]*, I. Chetoui [1], K. Telahigue [1], A. Besbes Benseddik [2], M. Azaza [2] and M. El Cafsi [1]
[1] FACULTE DES SCIENCES DE TUNIS - Rabehimen@yahoo.fr
[2] Institut National des Sciences et Technologies de la Mer (INSTM Centre de Monastir)

Abstract
Lipid classes and fatty acid composition of polar, neutral lipid fractions and the fatty acid composition of grey mullet *Chelon labrosus* from the geothermal water were determined. (PC) and (PE) was the main component in the Polar class as the TAG in the neutral lipid. Docosahexaenoic acid (22:6n-3) and eicosapentanoic acid (20:5n-3) were rich in the PC and PE fractions. Saturated fatty acids (SFA) were the most representative, followed by Monounsaturated fatty acids (MUFA) in the neutral fraction. The major constituents of total fatty acids in *Chelon labrosus* were saturated: palmitic (16:0) andstearic acid (18:0), monoenes: oleic (18:1) and palmitoleic acid (16:1), polyunsaturated: arachidonic (20:4 n-6), eicosapentaenoic (20:5 n-3) and docosahexaenoic acid (22:6n-3), but their amounts differed significantly.
Keywords: Aquaculture, Fishes, Physiology

Introduction
The thick lipped grey mullet (*Chelon labrosus*) belongs of the family Mugilidae order Perciformes. This species are very euryhaline with some estuarine and freshwater families providing a good model for the assessment of physiological plasticity related to changes in environmental salinity. Grey mullet (Osteichthyes, Mugilidae) commonly inhabit tropical and warm-temperate estuaries [1]**.** In Tunisia It has been demonstrated that *Chelon labrosus* can live in geothermal water in the south of the country. In the past ten years, investigations have shown the significant potential of the geothermal, brackish water for the successful culture of aquatic organisms (fish, crustaceans, algae, etc). The present study was carried out to examine lipid classes, and fatty acid compositions of the grey mullet muscle adapted to the geothermal water, in order to acquire data for lipid biochemistry in grey mullet (*Chelon labrosus*).

Materials and methods
Fish: Immature thick lipped grey mullet (*Chelon labrosus*) (30–40g body mass) were provided by an experimental fish culturing centre in south of the country (Béchima (INSTM -Tunisia).
Lipid analysis: Total lipids were extracted with chloroform: methanol (2:1, v/v)) using the method of Folch [2].
Separation of lipid classes: Lipid class separation was performed by thin layer chromatography TLC Two dimensional on silica-gel plates according to [3]. Each lipid class is subjected afterwards to gas chromatography.
Statistical analysis: data were analysed for significant difference of means, ANOVA, and inspected by Duncan test at level of $p < 0.05$.

Results and discussion
In the analysed muscle tissue samples, we identified 22 identified fatty acids in *Chelon labrosus* in muscle tissue samples. Palmitic (16:0, 34.25 %), stearic (18:0, 6.8 %) oleic (18:1 n-9, 22.2 %) and linoleic (18:2n-6, 12.52 %) acid were the most abundant fatty acids in muscle of *Chelon labrosus*. Lower quantities of docosahexaenoic acid (DHA 22:6 n-3, 1.7%), eicosapentaenoic acid (EPA 20:5 n-3, 1.4%), arachidonic acid (20:4 n-6, 0.8%). Polar lipid fractions (PI, PS, PC, and PE) from the analysed fish species in this study contained a great variety of different fatty acids. On the other hand, TG were poorer in the diversity of fatty acids and contained a minor of different fatty acid. All of the identified fatty acids were found in Polar lipid fractions.

References
1 - Pombo, L., M. Elliott and J.E. Rebelo., 2005. Environmental influences on fish assemblage distribution of an estuarine coastal lagoon, Ria de Aveiro (Portugal). *Sci. Mar.*, 69: 143-159.
2 - Folch J., Less M., and Sloane-Stanley C.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem*., 266 : 497;509
3 - ChristieW.W., 1982 Lipid analysis. Isolation .Identification and structural Analysis Lipids .Oxford, PA: Pergamon Press.

ABUNDANCE AND BIOMASS OF FILAMENTOUS CYANOBACTERIAE IN A MEDITERRANEAN SALT MARSH

R. Rebai [1]*, N. Annabi Trabelsi [1], W. Guermazi [1], J. Elloumi [1], A. Bouain [1] and H. Ayadi [1]
[1] Université de Sfax, Faculté des Sciences de Sfax, Département des Sciences de la Vie. Unité de recherche UR/05ES05 Biodiversité et Ecosystème Aquatiques, Route soukra Km 3,5, B.P. 1171, CP 3000 Sfax, Tunisie - raydakobbi@yahoo.fr

Abstract
The aim of the present study is to understand the changes in the abundance and biomass of filamentous cyanobacteria with increase of salinity. Monthly samples over a period of one year (2007-2008) at three ponds (A1, A5 and C21) in the salt works of Sfax were collected and analyzed. Densities and biomasses of filamentous cyanobacteria decreased with the increase of salinity. This group uptake preferentially nitrites and ortophosphates at high salinities (> 62).
Keywords: Nutrients, Salinity, Cyanobacteria

Introduction
Phototrophic prokaryotes cyanobacteria are important primary producers especially in oligotrophic waters and the open ocean [1]. They have a higher nutrient affinity than eukaryotic algae, enabling them to grow under low nutrient concentrations [2]. They are thought to be favored by low (lower than 15) [3] N:P and Si:N ratios [4]. The objective of this study is to evaluate the influence of salinity increase on cyanobacteria abundance, biomass and nutrients uptake.

Materials and methods
Monthly samples were collected over a period of twelve months (September 2007 - August 2008) at three ponds (A1, A5 and C21) in the salt works of Sfax (central-eastern coast of Tunisia, about 34°, 390N and 10°, 420E). Salinity was estimated by the dry residue method, which consisted in evaporating a 50 ml sample (24 h, 120°C) in a previously sterilized crystallizing dish (by heating at 550°C for 1 h), and calculating the salt content from the difference in weight before and after evaporation. Samples for dissolved inorganic nitrogen (nitrite: NO_2^-, nitrate: NO_3^-, ammonium: NH_4^+), silicates $Si(OH)_4$ and orthophosphates (PO_4^{3-}) were stored at −20 °C before analysis with an automatic BRAN and LUE BBE-type 3 analyzer. Phytoplankton samples (200 ml) were fixed by Lugol-iodine solution (final concentration 1%, v/v) and counted under an inverted microscope (x 400) [5]. In this study, filamentous cyanobacteria were determined together with phytoplankton and not as single cells, e.g. *Synechococcus*, because we did not use epifluorescence. Biomass was calculated from mean biovolumes taking into consideration that 10^6 µm^3 = 1 µg (wet weight), assuming that organic cell carbon represented 12% of wet weight biomass. Pearson's correlation test was applied.

Results and discussion
The mean values found for all parameters during this study are summarized in Table 1.

Tab. 1. Average values of the biological, physical, and chemical parameters in three ponds (A1, A5 and C21) in Sfax salt works

Ponds	A1	A5	C21
filamentous cyanobacteriae density (ind.l^{-1})	1850	1025	400
filamentous cyanobacteriae biomass (µg.l^{-1})	667	309.8	150.9
Salinity	50.44 ± 7.12	62.79 ± 10.73	101.20 ± 12.58
NO_2^- (µmol. l^{-1})	0.25 ± 0.20	1.33 ± 2.24	0.54 ± 0.40
NO_3^-(µmol. l^{-1})	6.52 ± 3.73	2.4 ± 1.29	4.87 ± 2.59
NH_4^+(µmol. l^{-1})	5.21 ± 5.81	6.37 ± 5.73	3.82 ± 4.25
$Si(OH)_4$ (µmol. l^{-1})	12.65 ± 13.84	6.22 ± 6.66	7.41 ± 8.66
PO_4^{3-}(µmol. l^{-1})	19.19 ± 11.95	15.37 ± 5.06	13.86 ± 10.64

Microscopic counting of water samples showed that filamentous cyanobacteria constituted only a small proportion of the entire phytoplankton biomass ranging from 0.59% at C21 to1.91% at A. Although, Over the year, N:P and Si:N ratios were very low in the three ponds not exceeding 11.4 and 8.1 respectively. The phytoplankton biomass was dominated by small unicellular (protozoa) dinoflagellates and diatoms. The average abundance and biomass of filamentous cyanobacteria decreased with the increase of salinity. The highest mean was recorded at A1 and the lowest one was found at C21 (Table 1). The persistence of filamentous cyanobacteria in the extreme saline conditions exerted upon them some ecological challenges, e.g., the production of some extracellular enzymes [6]. Both filamentous cyanobacteria abundance and biomass showed highly significant positive correlations ($P<0.01$) with orthophosphates only at C21. They were able to accumulate phosphorus directly and they became enriched in phosphorus to a greater degree than other phytoplankton organisms [7]. Nitrites were preferentially and significantly used by filamentous cyanobacteria at A5 ($r= 0.996$; $P<0.01$) and C21 ($r= 0.845$; $P<0.01$).

References
1 - Glover, H.E., Campbell, L., Prezelin, B.B., 1986. Contribution of *Synechococcus* spp.to size-fractionated primary productivity in three water masses in the Northwest Atlantic. *Mar. Biol.* 91, 193-203
2 - Domingues R.B., A. Barbosa and H. Galvão., 2005. Nutrients, light and phytoplankton succession in a temperate estuary (the Guadiana, south-western Iberia), *Estuar. Coast. Shelf Sci***.** 64, 249–260.
3 - Sommer U., A., 1999. Comment on the proper use of nutrient ratios in microalgal ecology**,** *Arch. Hydrobiol. 146, 55–64.*
4 - Rocha C., H. Galvão and A. Barbosa., 2002. Role of transient silicon limitation in the development of cyanobacteria blooms in the Guadiana estuary, south-western Iberia, *Mar. Ecol. Prog. Ser.* 228, 35–45.
5 - Uthermöhl H., 1958. Zur vervollkommnung der quantative phytoplankton-methodik. Mitt. *Inst. Verh. Limn*. 9: 1-38.
6 - Zhang W., Y. Feng, 2008. Characterization of nitrogen-fixing moderate halophilic cyanobacteria isolated from saline soils of Songnen Plain in China. *Prog. Natural Sci*., 18: 769-773.
7 - Nausch M., G. Nausch, H. Ulrich Lass, V. Mohrholz, K. Nagel, H. Siegel, N. Wasmund., 2009. Phosphorus input by upwelling in the eastern Gotland Basin (Baltic Sea) in summer and its effects on filamentous cyanobacteria. *Estuar. Coast. Shelf Sci*.83: 434-442.

SMALL SEA FISH AS SOURCE OF GLYCOSAMINOGLYCANS, ESSENTIAL AMINO ACIDS, ESSENTIAL FATTY ACIDS AND MICROELEMENTS USED FOR PHARMACEUTICAL PURPOSES

Natalia Rosoiu [1]*, Laura Olariu [2] and Roxana Nita [2]
[1] "Ovidius" University, Constanta, Romania; Academy of Romanian Scientists, 050094 Bucharest, Romania - natalia_rosoiu@yahoo.com
[2] S.C. Biotehnos S.A., 075100 Otopeni, Romania

Abstract
By an original patented technology we have obtained a bioactive complex from *Engraulis encrassicolus ponticus, Sprattus sprattus sprattus and Odontogadus merlangus euxinus*, constituted by glycosaminoglycans, essential amino acids, essential fatty acids, eicosanoids, glycerolphosphates, and microelements. So, by their chemical composition, the bioactive extracts from small sea fish is useful to prevent unsettle of the macromolecular structure and keep the functionality of the extracellular matrix from conjunctive, cartilaginous and bone tissue.
Keywords: Biotechnologies, Black Sea, Fishes

Sea organisms arouse a major interest for the extraction of biological active substances with multiple and valuable therapeutical applications all over the world [1], [2].This work provides for the elaboration of an original extraction and purification technology of glicosaminoglicans from sea organisms (small sea fish) and their chemical, biological and pharmacological analysis together with *in vitro* and *in vivo* tests, for the purpose of extracts' conditioning towards their use as pharmaceutical products (unguents, pastilles) with anti-inflammatory activity, tissue restitution properties, anticlotting and antithrombothic activities, biostimulating, antioxidative, hepatoprotective and antiproliferative qualities. The physico-chemical analysis of different batches obtained in laboratory revealed that obtained extracts from small see fish represent a complex of active biological substances composed from glycosaminoglycans (44-60% sulfated form), amino acids 3.5-12%, from which 2-6.5%, essential amino acids (valine, leucine, isoleucine, threonine, methionine, lysine, phenylalanine, tryptophan), essential fatty acids 1-2% (linoleic acid, arachidonic acid). There were identified glicerophosphates, creatinin, mineral salts (Ca, Na, K, Fe, Mg, Se, Ni, Cu, Si) [3]. The extracts show a dose dependent inhibition of hyaluronidase and induce a significant decrease of elastase (MMP12) and collagenase (MMP1) ezymatic activity; also favor the *in vitro* collagen fibrils formation, manifest a strong antioxidant activity, that is present a very valuable therapeutically activitywhich will be capitalized in medicine and dermo-cosmetics products. Bioactive complexes rich in glycosaminoglycans obtained from small sea fish manifest a strong anti-inflammatory activity comparatively with "diclofenac". Taking into consideration the presented results, the chemical composition of the bioactive complexes obtained from small sea fish and the therapeutic effects highlighted by *in vitro* and *in vivo* experiments shows that these extracts can be conditioned and used successfully in the form of medicinal products with valuable therapeutic properties and minimal side effects.

References
1 - Serban M., Rosoiu N., 1992, Biological active substances from marine organisms, Ed. Romanian Academy, Bucharest. 2. Kornprobst J.M., 2005, Substances naturelles d'origine marine, Editions TEC & DOC, London-Paris-New York. 3. Rosoiu N., Nita R., Olariu L., Drumea V., Ene M.D., 2008, Original bioactive complexes rich in glycosaminoglycans obtained from small fish, *Roum. Biotechnol.Lett*., 13, 5, 3944-3954.

RESTING STAGES PRODUCED BY PLANKTON IN THE BLACK SEA – BIODIVERSITY AND ECOLOGICAL PERSPECTIVE

F. Rubino [1]*, S. Moncheva [2], M. Belmonte [1], N. Slabakova [2] and L. Kamburska [3]

[1] Institute of Oceanology-Bulgarian Academy of Sciences, P.O .Box 152, Varna, 9000, Bulgaria

[2] European Commission, Joint Research Centre, Institute for Environment and Sustainability, via E. Fermi 2749, TP. 272, Ispra 21027, Italy

[3] C.N.R. - Institute for Coastal Marine Environment, Talassografico "A. Cerruti" 3-74100 Taranto, Italy - rubino@iamc.cnr.it

Abstract

To study the potential "hidden" biodiversity of the plankton in the Western Black Sea and species that could represent an ecological concern in the future, resting cysts were analyzed for the first time in superficial sediments along a transect offshore the city of Varna (Bulgaria) and a sediment trap material from the open sea. An interesting finding was the record of eight species (in resting phase), new in the Black Sea. Based on the bioinvasion history and the ecological affinity of the observed species (cysts), the results suggest future implications for the Black Sea ecosystem and biodiversity.

Keywords: Plankton, Biodiversity, Blooms, Sediments, Black Sea

Introduction

Resting stage (cyst) production is a common life-cycle trait in many species of the marine plankton of multiple function: a strategy to overcome unfavourable conditions, a "seed population" for bloom initiation and re-colonization of the pelagic domain, aiding in the genetic recombination of the population and more effective mobilization of nutrients. Both, the abundance of resting stages in the sediments and the number of cyst-producing species suggest this trait as a driving force of plankton dynamics and biodiversity [1]. As in the framework of the EU SESAME Project, one of the general objectives was to assess and predict changes in the Black Sea ecosystem, the study of cyst bank produced by plankton was deemed an efficient approach, since these assemblages play the role of a "memory" and "early warning" of the plankton structural dynamics, storing the information about past and future communities. As the first targeted research of this scale in the Black Sea, the primary goal was to study plankton biodiversity hidden in the sea floor as modern cyst assemblages.

Study area and Methods

Surface sediments were sampled between April 2008 and April 2009 at 12 stations in the Western Black Sea (Galata transect) during 3 cruise campaigns. In addition material collected by a sediment trap deployed at 900 m in the deep sea was analyzed too. Sub-samples were processed by means of a sieving technique [2] to concentrate cysts for their identification under light microscope and for germination experiments.

Tab. 1. List of the 64 resting stage *taxa* from Western Black Sea sediments.
♦new records for the study area
§cyst morphotypes found only in the sediment trap

	Dinophyta		*Scrippsiella trochoidea* (Stein) Loeblich III
♦	*Alexandrium minutum* (Halim) Balech		*Scrippsiella* sp.1
♦	*Alexandrium tamarense* (Lebour) Balech		*Scrippsiella* sp.2
	Alexandrium sp.		*Scrippsiella* sp.3
	Bicarinellum tricarinelloides Versteegh		*Scrippsiella* sp.4
§	*Calcicarpinum perfectum* Versteegh	§	*Scrippsiella* sp.5
♦	*Calciodinellum operosum* Deflandre		Dinophyta sp.1
	Calciodinellum sp.		Dinophyta sp.2
	Calciperidinium asymmetricum Versteegh		Dinophyta sp.3
♦	*Cochlodinium polykrikoides* Margalef		Dinophyta sp.4
	Diplopsalis lenticula Bergh		Dinophyta sp.5
	Diplopsalis sp.		Dinophyta sp.6
	Gonyaulax group		Dinophyta sp.7
♦	*Gymnodinium impudicum* (Fraga & Bravo) Hansen & Moestrup		Dinophyta sp.8
♦	*Gymnodinium nolleri* Ellegaard & Moestrup		Dinophyta sp.9
	Gymnodinium sp.		Dinophyta sp.10
§	Gymnodiniales sp.		Dinophyta sp.11
	Lingulodinium polyedrum (Stein) Dodge		Dinophyta sp.12
	Melodomuncula berlinensis Versteegh		Dinophyta sp.13
	Oblea rotunda (Lebour) Balech ex Sournia		
	Pentapharsodinium dalei Indelicato & Loeblich		**Ciliophora**
	Pentapharsodinium tyrrhenicum (Balech) Montresor, Zingone & Marino	§	*Cyrtostrombidium boreale* Kim, Suzuki & Taniquchi
	Pheopolykrikos hartmannii (Zimmerman) Matsuoka & Fukuyo		*Strombidium acutum* Leegaard
	Polykrikos kofoidii Chatton		*Strombidium conicum* Kim & Taniguchi
§	*Protoceratium reticulatum* (Claparède & Lachmann) Bütschli		Ciliophora sp.1
	Protoperidinium compressum (Abé) Balech		Ciliophora sp.2
	Protoperidinium conicum (Gran) Balech	§	Ciliophora sp.3
	Protoperidinium oblongum (Aurivillius) Parke & Dodge		Ciliophora sp.4
	Protoperidinium thorianum (Paulsen) Balech		
	Protoperidinium sp.1		**Rotifera**
§	*Protoperidinium* sp.2	§	*Synchaeta* sp.
§	*Protoperidinium* sp.3		
♦	*Scrippsiella lachrymosa* Lewis		**Copepoda**
♦	*Scrippsiella ramonii* Montresor	§	*Acartia* sp.1
♦§	*Scrippsiella spinifera* Honsell & Cabrini	§	*Acartia* sp.2
♦	*Scrippsiella trifida* (Stein) Loeblich III		

Results and Discussion

In the surface sediment samples a total of 59 cyst morphotypes were determined, mostly produced by dinoflagellates, out of which 5 were identified as ciliate resting stages based on their peculiar flask-like shape. In the sediment trap sample, 45 different morphotypes were found, mostly dinocysts, together with two ciliates flasks, one rotifer and two *Acartia* resting eggs (copepod). In the sediment trap material 12 different cyst morphotypes not present in the surface sediments were discovered. Thus the total number of cyst morphotypes observed in this study was 71, out of which 61 produced by dinoflagellates, 7 by ciliates, 1 by rotifers and two by copepods, corresponding to 64 *taxa* (Table 1).

Even if cyst-forming species constitute a small part of the plankton dinoflagellates recorded in the area, eight species, have never been observed in the Black Sea (Table 1). Three of them were detected also for the first time in the plankton samples collected during the SESAME cruises. *Alexandrium tamarense* (cyst) and *Cochlodinium polykrikoides* (motile cells) have been reported in surface sediments and water column respectively from Odessa Bay (Northern Black Sea) [3], but for the Bulgarian area this represents the first record.

The most abundant cyst morphotypes at all stations were those produced by *Scrippsiella trochoidea* (Stein) Loeblich III, a species responsible for frequent blooms in the area. As evident from the species (cyst) list a high variety of *Scrippsiella* species (cysts) was recognized among which 4 new for the Black Sea phytoplankton. The proportion of cysts density shed light on the co-existence of *Pentapharsodinium dalei* - *P. tyrrhenicum* - *S. trochoidea*, confirming the dominance of *S. trochoidea* in the phytoplankton assembly. The results suggest that the originally reported *S. trochoidea*, in fact, represents a variety of species, *e.g.* should be treated as *Scrippsiella complex*. Some interesting findings were related to the paleontological *taxa Bicarinellum tricarinelloides*, *Calcicarpinum perfectum*, *Calciperidinium asymmetricum* and *Melodomuncula berlinensis*, whose active stages are not known. But, their increasing records from the surface sediments and trap samples, together with some successful germination experiments, testify the modern status of the species, as the case of *Calciodinellum operosum*, originally described as fossil by Deflandre. These new records confirm the need to carry out an integrated study of water column and sediments which could complete the list of species [4] and add value to potential implications for the pelagic ecosystem. The recent history of bioinvasions in this particular environment, calls for further investigations of biodiversity as an imperative for the sustainable management of the Black Sea ecosystem.

References

1 - Boero F., Belmonte G., Fanelli G., Piraino S. and Rubino F., 1996. The continuity of living matter and the discontinuities of its constituents: do plankton and benthos really exist? *Trends Ecol. Evol.*, 11: 177-180.

2 - Rubino F., Belmonte M., Caroppo C. and Giacobbe M., 2009. Dinoflagellate resting stages from surface sediments of Syracuse Bay (Western Ionian Sea, Mediterranean). *Deep Sea Res. II*, doi:10.1016/j.dsr2.2009.09.011.

3 - Terenko L., 2005. New dinoflagellate (Dinoflagellata) species from the Odessa Bay of the Black Sea. *Oceanol. Hydrol. Studies*, 34: 205-216.

4 - Rubino F., Saracino O.D., Moscatello S. and Belmonte G., 2009. An integrated water/sediment approach to study plankton (a case study in the southern Adriatic Sea). *J. Mar. Syst.*, 78: 536-546.

BIOFILM COMMUNITY AS A TOOL FOR MONITORING DISSOLVED AQUACULTURE WASTES

C. Sanz-Lázaro [1]*, F. Navarrete-Mier [1], M. D. Belando [1], P. S. Morillo-Velarde [1], D. Celdrán [1] and A. Marín [1]
[1] Departamento de Ecología e Hidrología. Facultad de Biología. Universidad de Murcia, 30003, Spain - carsanz@um.es

Abstract

The aim of this work was to test biofilm as a tool to detect and quantify fish farm wastes related to OM and metals. Glass slides were deployed along a spatial transect from a fish farm in June and September of 2008 for the same time span (16 days). After the retrieval of the slides element concentrations and stable isotopes concentrations $\delta^{13}C$ and $\delta^{15}N$ were measured. This work demonstrates that fish farm releases important quantities not only of carbon and nutrients but also of Cu and Zn and demonstrates that biofilm can be used as a useful tool to monitor these wastes.

Keywords: Aquaculture, Eutrophication, Organic Matter, Metals

Relatively few studies have examined the effects of fish farm inputs on the pelagic environment [1] and these studies have shown little or no effect of dissolved wastes on most of the studied variables [2]. Even though, the release of dissolved wastes from aquaculture practices is considerable large and maybe, the experimental designs used in the studies to date, have failed to demonstrate aquaculture impact on the water column [3] due to the dilution of the pollutants. Metals are other pollutants derived from aquaculture practices, (e.g. feed and antifouling products), which have being little studied in the benthic system [4], but nothing in the water column. Microbial communities are highly sensitive to changes in water quality and respond rapidly to changing environmental conditions. Analysing shifts in microbial community structure on artificial biofilm surfaces facilitates a direct comparison of communities between sites without confounding environmental and physical variables [5]. Stable isotopes are used to elucidate the source of carbon (C) and nitrogen, but also have helped to investigate the trophic status of the whole community compared to another. The aim of this work was to test biofilm as a tool to detect and quantify fish farm wastes related to OM and metals.

Glass slides were deployed along a spatial transect from a fish farm in June and September of 2008 for the same time span (16 days). After the retrieval of the slides C, N, P, Fe, Mn, Cu, Zn, Cd, Pb, Ni, As, Cr, Tl, Ba, Se, Sn, Sb concentrations were measured. Same, stable isotopes concentrations $\delta^{13}C$ and $\delta^{15}N$ were measured. Results showed that C, nutrients (N, P) as well as Cu and Zn were clearly affected by fish farm activity, showing a marked accumulation compared to reference stations in both seasons. This work demonstrates that fish farm releases important quantities not only of C and nutrient but also of Cu and Zn and demonstrates that biofilm can be used as a useful tool to monitor these wastes.

References

1 - Navarro N, Leakey RJG, Black KD. 2008. Effect of salmon cage aquaculture on the pelagic environment of temperate coastal waters: seasonal changes in nutrients and microbial community. *Marine Ecology-Progress Series* 361:47-58.

2 - Pitta P, Apostolaki ET, Tsagaraki T, Tsapakis M, Karakassis I. 2006. Fish farming effects on chemical and microbial variables of the water column: A spatio-temporal study along the Mediterranean Sea. *Hydrobiologia* 563:99-108.

3 - Sara G. 2007. A meta-analysis on the ecological effects of aquaculture on the water column: Dissolved nutrients. *Marine Environmental Research* 63:390-408.

4 - Dean RJ, Shimmield TM, Black KD. 2007. Copper, zinc and cadmium in marine cage fish farm sediments: An extensive survey. *Environmental Pollution* 145:84-95.

5 - Webster NS, Negri AP. 2006. Site-specific variation in Antarctic marine biofilms established on artificial surfaces. *Environmental Microbiology* 8:1177-1190.

EFFECTS OF DRYING PROCESS ON LIPID QUALITY OF SILVERSIDE (FISH) *ATHERINA LAGUNAE*

Salah Selmi [1], Nawzet Bouriga [2]* and Monia Trabelsi [2]
[1] Institut National des Sciences et Technologies de la Mer
[2] Faculté des Sciences de Tunis. Unité de Biologie Marine. Manar II, 2092 Campus universitaire. Tunisie. - hanounawsset@live.fr

Abstract
Changes in lipid quality of silverside during solar and hot air drying process were investigated. Total fatty acid content in silverside was 5.42 g/100g fresh sample. N-3 and n-6 polyunsaturated fatty acids levels were 0.59 and 0.62 g/100g fresh silverside respectively. Therefore, all fatty acid groups increased significantly ($p<0.05$) within processing with higher levels in experimental drying process. After hot air and solar drying treatments, PV and TBARS of the total lipids increased significantly ($p <0.05$) to reach 2.58 and 3.41 meq active O_2/kg oil and 0.87 and 1.27 mg MA/kg oil, respectively.

Keywords: Fishes, Chemical Analysis

Introduction
Lipids of marine fish are rich in n-3 long chain polyunsaturated fatty acids [1] of excellent nutritional value. However, they are very prone to oxidation which is also favoured by processing. In Tunisia, silversides are traditionally dried by spreading out on sand along the beaches for about 4 and 5 days in summer. In attempt to reduce some of the problems associated with losses, especially in lipid quality and time processing, experimental drying with automated conditions have been investigated and compared with traditional drying process.

Materials and methods
Tunisian silversides *Atherina lagunae* (belonging to the same sampling catch) were separated into three lots : (i) the first one was used for raw material, (ii) the second lot was traditionally sun dried, (iii) the third lot was dried using an electric drying unit. The temperature and relative humidity were maintained at 50°C and 15.02 % respectively. After lipid extraction and derivatisation, the resulting methyl esters were analysed using an Agilent Gaz chromatograph system 6890N. Peroxide value PV was determined according to the ferric thiocyanate method [2]. Thiobarbituric acid reactive substances TBARS were determined according to the AOCS method [3].

Results and discussion
In fresh silverside, saturated fatty acids SFA (2.49 g/100g silverside) constitute the majority of the fatty acids pool, followed by monounsaturated MUFA (1.7 g/100g silverside) and polyunsaturated fatty acids PUFA (1.23 g/100g silverside) (Table 1).

Tab. 1. Fatty acid profile (expressed as g fatty acid /100g edible silverside) of total silverside *Atherina lagunae* lipids

Fatty acid	FS	SDS	EDS
Total SFA	2.49 ±0.06	7.09 ±0.08	7.38 ±0.08
Total MUFA	1.70 ±0.07	4.43 ±0.08	5.03 ±0.08
Total PUFA	1.23±0.13	2.96 ±0.12	3.51 ±0.16

N-3 and n-6 PUFA levels were 0.59 and 0.62 g/100g fresh silverside respectively, in which, 22:6 n-3 and 18:2 n-6 were the prominent PUFA. Drying processes show significant differences ($p<0.05$) in fatty acid content. Therefore, all fatty acid groups increased within drying treatment with higher levels in experimental drying process. These results suggest that dried silverside is a good source of n-3 and n-6 fatty acids. Results show that drying process had a significant effect ($p < 0.05$) on the formation of primary oxidation products in the samples, with higher PV levels obtained in solar dried silverside.

Tab. 2. Changes in PV and TBARS of silverside *Atherina lagunae* during solar and experimental drying process. PV: peroxide value. TBARS: Thiobarbituric acid reactive substances. MA: malonaldehyde

	FS	SDS	EDS
PV (meq active O_2/kg oil)	0.73 ±0.06	3.41 ±0.11	2.58 ±0.13
TBARS (mg MA/kg oil)	0.48 ±0.06	1.27 ±0.09	0.87 ±0.07

The increase in PV levels is probably due to the temperature of drying and the high content of unsaturated fatty acids. Such results are in agreement with other authors [4] who reported that peroxide value of *migaki-nishin* lipid increased rapidly from 5.52 to 11.86 meq/kg within 4 days of drying and then gradually increased up to 10 days of drying (16.07 meq/kg). The initial value of TBARS was 0.48 mg MA/kg oil, suggesting that lipid oxidation did not occurre during post-mortem handling to some extent. From this result, TBARS slightly increased within drying treatment to reach in solar and experimental dried silverside1.27 and 0.87 mg MA/kg oil respectively.

Conclusion
Results show that solar and experimental drying processes have significant effects on lipid quality. Fresh silverside showed considerable polyunsaturated fatty acids content, and these results suggest that dried silversides are good sources of n-3 and n-6 fatty acids.

References
1 - Osman H., Suriah A.R. and Law, E.C., 2001. Fatty acid composition and cholesterol content of selected marine fish in Malaysian waters. *Food Chem.*, 73: 55-60.
2 - Chapman R. and Mckay J., 1949. The Estimation of Peroxides in Fats and Oils by the Ferric Thiocyanate Method. *J. Am. Oil Chemists Soc.*, 26: 360-363.
3 - AOCS., 1998. Official Methods and Recommended Practices of the American Oil Chemists' Society, 5th ed. (D. Firestone, ed.). Official method Cd 19-90, 2-Thiobarbituric acid value. Champaign, Ill.
4 - Azad Shah, A. K. M., Tokunaga, C., Kurihara, H. & Takahashi, K., 2009. Changes in lipids and their contribution to the taste of *migaki-nishin* (dried herring fillet) during drying. *Food Chem.*, 115: 1011-1018.

ANTIBIOTIC RESISTANCE OF ENTERIC BACTERIA ISOLATED FROM SOUTH-WESTERN ISTANBUL COAST (TURKEY)

Nüket Sivri [1]*, Gozde Ozbayram [1] and Zeynep Karatut [1]
[1] Istanbul University, Engineering Faculty, Environmental Engineering Dept. - sivrin@gmail.com

Abstract
The aim of this study was to evaluate the impact of an urban effluent on the antibiotic resistance of enteric bacteria. A total of 72 strains were isolated from five different sampling stations of south-western Istanbul coast during the year of 2008. Among the isolates, 55,6% were *Escherichia coli*, 29,2% *Enterococcus fecalis*, 6,9 %, *Proteus* spp., 5,6% *Klebsiella* spp., 2,7 % *Pseudomonas* spp. Strains of enteric bacteria were selected for antibiotic susceptibility testing. The antibiotic resistance tests resulted in bacteria being the most resistant against Ampicilin (100%) and the most sensitive against Imipenem (0%) and Amikacine (7,6%). The results reveal that study area faces bacteriological pollution and existing pollution level in this area is above the criterion specified for aquaculture, fishery and recreational activity.
Keywords: Antibiotics, Bacteria, Sewage Pollution

Introduction
The quality of water is of vital importance to the society. If a bacterial pathogen is able to develop or acquire resistance to an antibiotic, then this substance becomes useless in the treatment of infectious disease caused by this pathogen [1,2]. The aim of this study was to evaluate the impact of an urban effluent on the antibiotic resistance of enteric bacteria isolated from surface water of south-western Istanbul coast, Turkey.

Materials and Methods
The enteric bacteria were isolated using the MPN Method from five different sampling stations of south-western Istanbul coast on a monthly basis during the year of 2008 (Figure 1). A total of 72 strains were isolated and strains of enteric bacteria were selected for antibiotic susceptibility testing. The minimum inhibition concentration was determined by the disk diffusion method in Mueller-Hinton medium in accordance with the Clinical and Laboratory Standards Institute (CLSI) guidelines. Ten antimicrobial agents were selected as representatives of important classes of antimicrobials: ampicillin (AM), 10 µg; amoxicillin-clavulanic acid (AMC), 10µg; tetracycline (TE), 30 µg; chloramphenicol (CM), 30 µg; nalidixic acid (NA), 30 µg; amikacin (AC), 30 µg; streptomycin (SM), 10 µg; imipenem (I), 10 µg; ceftazidime (CAZ), 10 µg; trimethoprim-sulfamethoxazole (CO^{25}), 25 µg. The results were separately interpreted, using the breakpoints from the CLSI guidelines for the family *Enterobacteriaceae* and non-fermenters [3,4,5,6].



Fig. 1. Sampling stations of south-western Istanbul coast [7]

Results and Discussion
In this study, 72 isolated strains were 55,6% *Escherichia coli*, 29,2% *Enterococcus fecalis*, 6,9 % *Proteus* spp., 5,6% *Klebsiella* spp., 2,7 % *Pseudomonas* spp. The results of the antibiotic sensitivity test were interpreted and are presented as the antibiotic resistance pattern of the bacterial isolates among sampling stations. It can be seen in Table 1. When comparing the antibiotic resistance level between sampling stations, highest resistance to antibiotics was determined in the first and third stations because those stations have drainage water that contains high concentration of fecal coliforms. Also indirect influences of bacterial pollution and negative environmental conditions may be assumed to be related to antibiotic-resistant strains. The antibiotic resistance tests show bacteria being the most resistant against Ampicilin (100%) and the most sensitive to Imipenem (0%) and Amikacine (7,6%). As detecting the antibiotic susceptibility profiles of the isolates, it would be possible to design a general classification of the isolates and beside this, the risk factors of the resistant strains in stations were determined. The results show that existing pollution in this area is above the given criteria's for aquaculture, fisheries and recreational activity.

	RESISTANCE TO ANTIBIOTICS (%)											
Bacterial groups	**Station**	**Isolates**	**CM^{30}**	**AC^{30}**	**SM^{10}**	**CO^{25}**	**NA^{30}**	**AMC^{30}**	**TE^{30}**	**AM^{10}**	**CAZ^{30}**	**I^{10}**
Escherichia coli	1	9	0	0	11	22,2	36,3	67	44,4	100	22,2	0
Enterococcus fecalis	1	5	20	0	40	20	80	80	20	100	40	0
Klebsiella spp.	1	1	0	0	100	0	0	100	0	100	0	0
Proteus spp.	1	1	0	0	100	100	0	100	0	100	100	0
TOTAL	**1**	**16**	**6,25**	**0**	**31,25**	**25**	**50**	**75**	**31,25**	**100**	**31,25**	**0**
Escherichia coli	2	8	25	12,5	25	25	37,5	62,5	37,5	100	12,5	0
Enterococcus fecalis	2	4	25	0	25	25	50	75	50	100	25	0
Proteus spp.	2	1	0	0	100	100	100	100	0	100	100	0
TOTAL	**2**	**13**	**23**	**7,6**	**30**	**30**	**46,1**	**69,2**	**30,7**	**100**	**23**	**0**
Escherichia coli	3	8	0	0	12,5	50	25	62,5	62,5	100	12,5	0
Enterococcus fecalis	3	4	25	0	25	25	50	75	100	100	25	0
Proteus spp.	3	1	0	0	0	0	0	0	100	100	100	0
Pseudomonas spp.	3	1	100	0	100	0	0	100	100	100	0	0
Klebsiella spp.	3	1	0	0	0	0	0	0	0	100	0	0
TOTAL	**3**	**15**	**13**	**0**	**20**	**33**	**26**	**60**	**73**	**100**	**20**	**0**
Escherichia coli	4	7	0	0	28,5	28,5	71,4	28,5	14,2	100	14,2	0
Enterococcus fecalis	4	3	0	0	33	33	100	67	33	100	0	0
Proteus spp.	4	1	0	0	100	0	100	100	0	100	0	0
Pseudomonas spp.	4	1	0	0	0	0	0	0	0	100	0	0
Klebsiella spp.	4	1	100	0	100	100	100	100	100	100	100	0
TOTAL	**4**	**13**	**7**	**0**	**38,4**	**30,7**	**77**	**46,1**	**23**	**100**	**15,3**	**0**
Escherichia coli	5	8	25	0	50	37,5	37,5	37,5	75	100	25	0
Enterococcus fecalis	5	5	40	0	60	20	60	80	60	100	0	0
Proteus spp.	5	1	0	0	0	0	0	0	0	100	100	0
Klebsiella spp.	5	1	0	0	0	0	0	0	0	0	100	0
TOTAL	**5**	**15**	**26,6**	**0**	**46,6**	**26,6**	**40**	**46,6**	**60**	**100**	**20**	**0**

Fig. 2. Antibiotic resistances levels of isolated bacteria

References
1 - Furushita, M., T. Shiba, T. Maeda, M. Yahata, A. Kaneoka, Y. Takahashi, K. Torii, T. Hasegawa, and M. Ohtal., 2003. Similarity of tetracycline resistance genes isolated from fish farm bacteria to those from clinical isolates. *Applied and Environmental Microbiology* 69:5336-5342.
2 - Toroglu, S., Dincer, S., Korkmaz, H., 2005. Antibiotic rsistance in Gram negative bacteria isolated from Aksu River in (Kahramanmaras) Turkey. *Annals of Microbiology* 55(3) 229-233.
3 - Kelsey R., Scott H.G.I., Porter D.E., Thompson B., and Webster L., 2003., Using multiple antibiotic resistance and land use characteristics to determine sources of fecal coliform bacterial pollution. *Environmental Monitoring and Assessment* 81:337-348.
4 - CLSI - Clinical and Laboratory Standards Institute (CLSI)., 2003. Performance standards for antimicrobial disk susceptibility tests; Eighth edn., Approved standard M2-A8., CLSI, Wayne, PA.
5 - Col, N. F. and R. W. O'Connor., 1987. Estimating worldwide current antibiotic usage: Report of task force I. *Rev. Infect. Dis.* 9, S232-243.
6 - Ash, R. J., B. Mauck, and M. Morgan., 2002. Antibiotic resistance of gram-negative bacteria in rivers, United States. *Emerg. Infect. Dis*. 8, 713-716.
7 - URL:http://www.nationsonline.org/oneworld/map/google_map_Istanbul.htm

PROLIFERATIVE STATUS DETERMINATION OF BENTIC INVERTEBRATES COELOMOCYTES/ HEMOCITES

Mirta Smodlaka [1]* and Sanda Ravlic [1]
[1] Center for Marine Research, Ruder Boškovic Institute - mirta@cim.irb.hr

Abstract
Flow cytometry was employed to determine the coelomocytes/hemocytes DNA content in five selected marine invertebrates from the Adriatic sea (sea mouse *Aphrodita aculeata*, spiny crab *Maja crispata*, starfish *Echinaster sepositus*, sea urchin *Paracentrotus lividus* and tunicate *Phallusia mammillata*). The cell cycle analyses identified sea mouse coelomocytes as proliferating cells and revealed that spiny crab hemocytes and sea urchin coelomocytes complete their division in the hemolymph and coelom, respectively. The diploid DNA content (2C) in sea mouse was 1.24 pg, spiny crab 7.76 pg, starfish 1.52 pg and sea urchin 1.08 pg
Keywords: Adriatic Sea, Cell, Bio-Indicators, Physiology

Marine invertebrates play a very important role in the maintenance of the health of marine ecosystems and serve as bio-indicators. Coelomocytes/hemocytes of benthic invertebrates, as primary immune effectors that respond to stress conditions, injures, host invasion and cytotoxic/genotoxic agents, have been used for the monitoring of environmental conditions [1, 2]. As a free circulating they are easily collected and analyzed by flow cytometry.

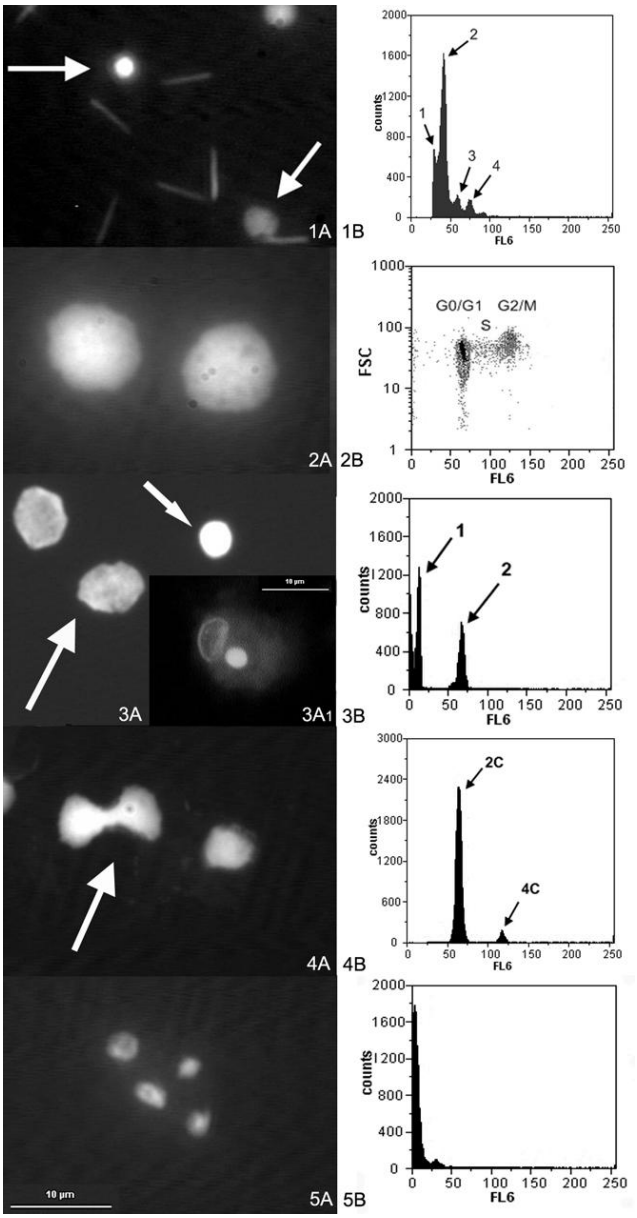


Fig. 1. (1) *Aphrodita aculeata*. (2) *Maja crispata*. (3) *Echinaster sepositus*. (4) *Paracenthrotus lividus*. (5) *Phallusia mammillata*. - (A) DAPI - stained nuclei and cells (3A1). (B) DAPI-fluorescence (FL6) distribution

The DNA content is a marker of cellular maturity since the frequency of cells is G0, S and G2 phases could determine the proliferative status of the investigated cells. When the measurement of DNA content is performed with internal standard, flow cytometry provides information about genome size [3].

Tab. 1. Descriptive statistics of genome size variation within 5 species of marine invertebrates calculated from distribution of DNA values of 10 specimens

Species	DNA content (2C)/pg	Range	CV
Aphrodita aculeata	1.24±0.06	1.15-1.30	4.8
Maja crispata	7.76±0.10	7.63-7.91	1.3
Echinaster sepositus	1.52±0.03	1.46-1.54	2.0
Paracenthrotus lividus	1.08±0.02	1.05-1.12	4.6
Phallusia mammillata	0.11±0.05	0.07-0.14	45

Conclusions

1. Flow cytometry analyses of DAPI-stained nuclei identified the sea mouse *A. aculeate* coelomocytes as proliferating cells.
2. Fluorescence microscopy of DAPI-stained cells identified the presence of phagocytic activity in unchallenged red starfish *E.sepositus*.
3. Evidence of karyokinesis of both spiny crab hemocytes and sea urchin coelomocytes revealed that their division is completed in the hemolymph and coelom, respectively.
4.The diploid DNA content (2C) in sea mouse *A. aculeata*, spiny crab *M. crispata*, red starfish *E. sepositus* and sea urchin *P. lividus* is 1.24, 7.76, 1.52 and 1.08 pg, respectively.
5. DNA content of sea mouse *A. aculeata* and spiny crab *M.crispata* are the first records of their genome size. Furthermore, the DNA content of the sea mouse *A. aculeata* is the first genome size record among the species in the Aphroditidae family.

References
1 - Bihari N. and Fafandel M., 2004. Interspecies differences in DNA single strand breaks caused by benzo(a)pyrene and marine environment. *Mutat. Res*. 552: 209-217.
2 - Bihari N., Micic M., Batel R. and Zahn R.K., 2003. Flow cytometric detection of DNA cell cycle alterations of hemocyte of mussels (*Mytilus galloprovincialis*) of the Adriatic cost, Croatia. *Aquat. Toxicol*. 64: 121-129.
3 - Rodríguez-Juíz A.M., Torrado M. and Méndez J., 1996. Genome size variation in bivalve molluscs determined by flow cytometry. *Mar. Biol*. 126: 489-497.

VARIABILITE JOURNALIERE ET VERTICALE DU PHYTOPLANCTON D UNE ZONE COTIERE DE LA COTE SUD ATLANTIQUE MAROCAINE

L. Somoue [1], O. Ettahiri [1], A. Berraho [1], A. Makaoui [1], H. Elghrib [2], J. Larissi [1] and S. Zizah [1]*
[1] Université Hassan II, Faculté des Sciences, 20800 Mohammedia, Maroc
[2] Institut National de Recherche Halieutique, 02 rue de Tiznit, Casablanca, 20000, Maroc - soukainazizah@yahoo.fr

Abstract
L'étude du cycle nycthéméral de la répartition verticale du phytoplancton au niveau de la zone 23°30'N en hiver et en été 2002 a révélé que le phytoplancton se développe principalement dans des eaux froides et moins ensoleillées. L'ensoleillement et le réchauffement thermique des couches de surface s'intensifieraient en hiver entre midi et 14h et en juillet au cours de la journée (entre 8h du matin et 20h), aboutissant à une diminution du développement du phytoplancton sur toutes la colonne d'eau en juillet et sur les couches superficielles en hiver, et favorisant ainsi son développement dans les eaux sous-jacentes froides et moins ensoleillées.
Keywords: Phytoplankton, Density, Vertical Profile, Upwelling

Introduction - Le phytoplancton constitue une composante de grand intérêt puisqu'il représente la base de toute vie dans les écosystèmes aquatiques. Son pouvoir élevé de multiplication, sous des conditions écologiques déterminées, permet un renouvellement rapide de la biomasse, et donc, le maintien des autres maillons trophiques ayant un intérêt économique (poissons, crustacés, céphalopodes, …) [1]. L'objectif de cette étude vise à décrire les variations journalières verticale et saisonnière des densités et structures des populations phytoplanctoniques.

Matériels et Méthodes - A bord du navire N/R Al Amir Moulay Abdallah, des prélèvements d'eaux destinés au dénombrement du phytoplancton, ont été effectués, au niveau d'une station côtière fixe située à 23°30'N. La position longitudinale de cette station diffère légèrement d'une saison à l'autre ; 16°7'W en janvier - février (31/01 au 01/02/2002) et 12°22'W en juillet (07/07 au 08/07/2002). L'échantillonnage a été réalisé avec un intervalle de temps régulier, toutes les 4 heures au cours de la saison froide et toutes les 6 heures en juillet 2002 et ce, à différentes profondeurs à l'aide de bouteilles reliées à une multisonde CTD qui s'ouvrent à chaque niveau de profondeur retenu. Le dénombrement du phytoplancton a été réalisé par la méthode d'Utermohl [8] et est exprimé en nombre de cellules par millilitre (cell.ml^{-1}).

Résultats et Discussion - L'étude de la variation du cycle nycthéméral de la répartition verticale du phytoplancton au niveau de la zone du 23°30'N en hiver et en été 2002, a révélé que les diatomées dominent l'ensemble du peuplement phytoplanctonique avec plus de 98%, aussi bien en surface qu'en profondeur et durant les deux saisons. Cette dominance est liée principalement à l'existence d´une remontée côtière hivernale et estivale connue de la région et un filament situé à la limite du talus continental de la zone de Dakhla. Ces deux facteurs contribuent á la haute disponibilité des nutriments au niveau de cette zone [3]. Plusieurs auteurs notamment Tilstone *et al.* [7] ont souligné que les nutriments élevés dans la zone euphotique pendant l'upwelling coïncident avec une biomasse élevée des diatomées. De même, les densités estivales du phytoplancton sont plus importantes que celles hivernales. La densité maximale hivernale était de l'ordre de 1 400 cell.ml^{-1}, alors que celle, estivale dépasse 2 000 cell.ml^{-1}. Ceci pourrait s'expliquer par la disponibilité des nutriments issus des remontées des eaux profondes qui caractérisent cette région, et qui sont intenses en été par rapport à l'hiver [4, 5, 3]. De plus, cette étude a montré une hétérogénéité inter saisonnière de la répartition journalière et verticale du phytoplancton. En hiver, les fortes densités phytoplanctoniques ont été observées dans les couches profondes entre 8h et 16h et principalement entre 12h et 14h, et dans les couches superficielles le soir à partir de 20 h (figure 1).

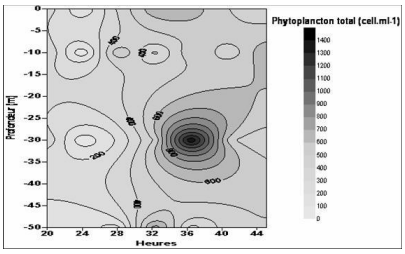


Fig. 1. Variation journalière et verticale des densités (cell.ml^{-1}) du phytoplancton total en janvier- février 2002

En été, les fortes densités ont été rencontrées le soir à partir de 20h dans les couches profondes et en surface la nuit à partir de 2h du matin (figure 2).

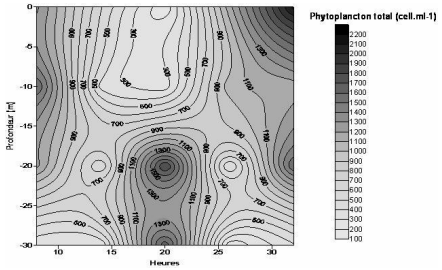


Fig. 2. Variation journalière et verticale des densités (cell.ml^{-1}) du phytoplancton total en juillet 2002

Donc, le degré d'ensoleillement et de réchauffement thermique pourrait être l'origine de la variabilité inter- et intra-saisonnière de la répartition verticale journalière du phytoplancton. Cet ensoleillement et réchauffement s'intensifieraient en surface en janvier – février entre midi et 14h et en juillet au cours de la journée (entre 8h du matin et 20h), aboutissant à une diminution du développement du phytoplancton sur les couches superficielles entre 12h et 14h en hiver et sur toutes la colonne d'eau en juillet durant la journée, et favorisant ainsi son développement dans les eaux froides et moins ensoleillées. Cela corrobore les résultats de Goffart *et al.* [2] qui ont noté que l'ensoleillement intense des eaux provoqueraient une auto inhibition du développement du phytoplancton du bassin Ligure (secteur Corse), où de très faibles densités phytoplanctoniques ont été observées dans toute la couche réchauffée. De même, les fortes intensités lumineuses ont une action inhibitrice sur les mécanismes photosynthétiques [6].

References
1 - Bougis P., 1974a. Ecologie du plancton marin, Tome I : Phytoplancton. Ed. Masson. 196 p.
2 - Goffart A., Hecq J. H. et Prieur L., 1995. Contrôle du phytoplancton du bassin Ligure par le front liguro-provençal (secteur Corse). *Oceano. Acta*, 18 (3): 329-342.
3 - Makaoui A., Orbi A., Hilmi K., Zizah S., Larissi J and Talbi M., 2005. L'upwelling de la côte atlantique du Maroc entre 1994 et 1998. C.R. *Geoscience* 337: 1518-1524.
4 - Mittelstaedt E., 1987. The surface waters of the Northwest Africa. A Description of the Regional Oceanography. Research Centre (ISPRA), 1 – 47.
5 - Roy C., 1992. Réponses des stocks de poissons pélagiques à la dynamique des upwellings en Afrique de l'Ouest : Analyse et Modélisation. Ed. ORSTOM. Collection Etudes et Thèses. Paris 1992. 5-146.
6 - Steemann Nielsen E., 1962. Inactivation of the photochemical mechanisms in photosynthesis as a mean to protect the cells against too high light intensities. *Physical. Plant*.15: 161-171.
7 - Tilstone G.H., Miguez B.M, Figueiras F.G. et Fermin E.G., 2000. Diatom dynamics in ecosystem affected by upwelling: coupling between species succession, circulation and biogeochemical processes. *Mar. Ecol. Progr. Ser*, 205: 23 – 41.
8 - Utermohl H., 1958. Zur vervollkommung der quantitativen phytoplankton methodik, Mitt Internat. Verein. *Theor Angew Limnol*, 9 (1): 1-38.

ANTIBACTERIAL ACTIVITY OF *GRACILARIOPSIS LONGISSIMA* (RHODOPHYTA, GRACILARIALES) LIPIDIC EXTRACT

L. Stabili [1]*, M. I. Acquaviva [1], F. Biandolino [1], R. A. Cavallo [1], E. Cecere [1], R. Lo Noce [1], M. Narracci [1] and A. Petrocelli [1]
[1] Istituto per l'Ambiente Marino Costiero (IAMC)-CNR, U.O.S. Taranto - loredana.stabili@iamc.cnr.it

Abstract
In this work we report the presence of an antibacterial activity in a seaweed, *Gracilariopsis longissima*, common in the Mar Piccolo of Taranto (Northern Ionian Sea, Italy). In particular, algal lipidic extract shows a bacteriostatic activity against several *Vibrio* species. Palmitic acid is predominant among the fatty acids and is presumably responsible for the antibacterial activity observed.
Keywords: Antibiotics, Algae, Bacteria, Ionian Sea

Introduction
With the advances in phytochemistry and pharmacology methods, several medicinal plants were screened for active principles and biological activities. Seaweeds are very abundant in coastal zones, where they sometimes reach high biomasses. Inspite of their abundance, they are less used than terrestrial plants as source of bioactive compounds with potential biotechnological interest. Only in recent years they increasingly attracted interest in the search for new drugs and have been shown to be a primary source of bioactive natural products including antibiotics. Therefore, an effort is made in the present investigation to screen a common red alga, namely *Gracilariopsis longissima*, for its antimicrobial activity.

Materials and Methods
In summer, *Gracilariopsis longissima* (S.G. Gmelin) Steentoft, L.M. Irvine et Farnham) was collected in the Mar Piccolo of Taranto. The selected algal material was washed 3-4 times in distilled water then shade dried for 8 d, and the fully dried material was powdered. The powdered material was subjected to Soxhlet extraction using chloroform/methanol (2:1 at 55-60 °C for 24 h). The extract was concentrated to dryness in a flask evaporator under reduced pressure and controlled temperature. Five milligrams of extract were dissolved in 1 ml of ethanol and assayed for antimicrobial activity using the Kirby Bauer method [1]. *In vitro* screening was carried out using several bacterial strains. Fatty acid composition was determined as described by Budge and Parrish [3]. Analysis of fatty acid methyl esters was performed by gas-liquid chromatography using a 6890 Hewlett Packard series gas chromatograph equipped with a Omegawax 250 capillary column (Supelco - USA).

Results and Discussions
Gracilariopsis longissima lipidic extract showed a bacteriostatic activity against all the *Vibrio* species utilized (*Vibrio alginolyticus, Vibrio fluvialis, Vibrio salmonicida, Vibrio vulnificus* and *Vibrio cholerae* non O-1). These results are interesting considering both the resistance against antibiotics developed by bacteria [5] and the need to control fish and shellfish diseases due to bacterial infections, including vibriosis [2]. The fatty acids profile of *Gracilariopsis longissima* showed that palmitic acid methyl ester (16:0) was the predominant saturated fatty acid (42%), whilst, among monounsaturated fatty acids oleic acid methyl ester (18:1) prevailed (8.5%). Since the palmitic acid represents the main component of fatty acids it is presumably responsible of the antibacterial activity observed in the target algal species. In several studies, indeed, palmitic acid has been reported to be the major antibacterial compound in a mixture of fatty acids from other algal species. The exact mechanism by which fatty acids exert their bactericidal action remains unresolved but it has been suggested that these molecules initiate peroxidative processes and inhibit bacterial fatty acid synthesis [6]. However, fatty acids may interact with cellular membranes causing leakage of molecules from the cells, reduction of nutrient uptake or inhibition of cellular respiration [4].

Table 1. Results of *in vitro* experiments showing the antibacterial activity of *Gracilariopsis longissima* lipidic extract .

Bacterial strain	**Diameter of bacterial growth inhibition (cm)**
Vibrio alginolyticus	2.5
Vibrio fluvialis	0.8
Vibrio salmonicida	0.8
Vibrio vulnificus	1.5
Vibrio cholerae non O-1	1

References
1 - Bauer A.W, Kirby W.M., Sherris J.C. and Turcck M., 1966. Antibiotic susceptibility testing by a standardized single disk method.*Am. J. Clin. Pathol.*, 45: 493-496.
2 - Bordas M.A., Balebona J.M., Rodriguez-Marotto J.M., Borrego J.J. and Morinigo M.A., 1998. Chemotaxis of pathogenic *Vibrio* strain towards mucus surfaces of gilt-head sea bream (*Sparus aurata*). *Appl. Environ. Microbiol*., 64 (4): 1573–1575.
3 - Budge S.M.and Parrish C.C., 2003 FA determination in cold water marine samples. *Lipids*, 38: 781–791.
4 - Desbois A.P., Lebl T., Yan L. and Smith V.J., 2008. Isolation and structural characterisation of two antibacterial free fatty acids from the marine diatom, *Phaeodactylum tricornutum. Appl Microbiol Biotechnol*., 81: 755–764
5 - Skjermo J. and Vadstein O., 1999. Techniques for microbial control in the intensive rearing of marine larvae. *Aquaculture*, 177: 333–343.
6 - Zheng C.J., Yoo J.S., Lee T.G., Cho H.Y., Kim Y.H. and Kim W.G., 2005. Fatty acid synthesis is a target for antibacterial activity of unsaturated fatty acids. *FEBS Lett* , 579: 5157–5162

VARIABILITY OF PHOTOSYNTHETIC PARAMETERS IN A SHALLOW TEMPERATE COASTAL AREA (GULF OF TRIESTE, ADRIATIC SEA)

Iva Talaber [1]* and Patricija Mozetic [1]

[1] National Institue of Biology, Marine Biology Station Piran, Slovenia - Iva.Talaber@mbss.org

Abstract

We studied the relationship between physico-chemical factors and photosynthetic parameters. P^B_{max} was mostly affected by temperature and phosphate. Overall, photosynthetic parameters showed less variability over the annual cycle in contrast to environmental factors and phytoplankton biomass.

Keywords: Adriatic Sea, Coastal Waters, Phytoplankton, Primary Production

INTRODUCTION

The highly variable hydrological and physicochemical conditions of the northern Adriatic are reflected in a high variability of phytoplankton. There is little information about the effect of environmental factors on photosynthetic properties of phytoplankton [1]. We studied this relationship in a shallow coastal area (Gulf of Trieste) and tried to establish the degree of variability of these parameters.

MATERIAL AND METHODS

Sampling was carried out biweekly from February 2009 onwards at one sampling site (1.3 NM off the coast, 22 m depth). *P-E* experiments were performed in a light incubator with samples taken from 5 and 15 m depth and inoculated with ^{14}C. Physicochemical parameters (CTD profiles, nutrients) and Chl *a* concentration were measured at each sampling. The photosynthetic parameters were derived from the experimental data fitted to the continuous exponential model of Platt *et al.* [2] (without the photoinhibition parameter, which was statistically equal to zero in all cases). Coefficient of variation for each variable and coefficients of correlation between variables (r) were calculated and the significance of r was tested with the two-sample paired *t*-test.

RESULTS AND DISCUSSION

Photosynthetic capacity (P^B_{max})varied from 0.72 to 6.10 mg C mg (Chl *a*)$^{-1}$ h^{-1}. The lowest value was found in April during mixed water column conditions, while the highest in July in the subsurface layer of higly stratified water column. Photosynthetic efficiency (α) ranged from 0.005 to 0.020 mg C (Chl *a*)$^{-1}$ h^{-1} (µmol photons m^{-2} s^{-1})$^{-1}$. In general, higher α were typicall for the 15-m depth layer. Coefficients of variation showed that nutrients and Chl *a* biomass were more variable than the photosynthetic parameters suggesting some physiological response of phytoplankton to environmental perturbations in order to maintain similar rates of photosynthetic capacity.

Tab. 1. Coefficients of correlation (r) between variables (n=23) and corresponding level of significance (** p<0.05, * p0.10)

	$T_{in\ situ}$	$E_{PAR(z)}$	PO_4^{3-}	α	P^B_{max}	E_k	Chl *a*
$T_{in\ situ}$	1						
$E_{PAR(z)}$	** 0,49	1					
PO_4^{3-}	0,27	0,32	1				
α	-0,10	0,11	-0,12	1			
P^B_{max}	** 0,49	* 0,38	** 0,46	0,17	1		
E_k	* 0,39	0,17	** 0,59	** -0,53	** 0,67	1	
Chl *a*	-0,17	** -0,45	0,01	0,17	-0,33	-0,29	1

α was not significantly correlated with any of the tested variables (table 1), and also varied independantly from P^B_{max}, which is in agreement with the fact that both parameters are controlled by independent mechanisms of the photosynthesis [3]. P^B_{max} was significantly correlated with temperature, which relates to the enzymatic control of photosynthesis. It was also significantly correlated with phosphate, which is the most limiting nutrient of the northern Adriatic [4]. The Chl *a* concentrations were significantly negatively correlated with $E_{PAR\ (z)}$,which suggests adjustment of Chl *a* cell content to the ambient light through photoacclimation.

References

1 - Mangoni O., Modigh M., Mozetic P., Bergamasco A., Rivaro P. and Saggiomo V., 2008. Structure and photosynthetic properties of phytoplankton assemblages in a highly dynamic system, the Northern Adriatic Sea. *Est.Coast. Shelf Sci.*, 77: 633-644.

2 - Platt T., Gallegos C.L. and Harrison W.G., 1980. Photoinhibition of photosynthesis in natural assemblages of marine phytoplankton. *J. Mar. Syst.*, 38: 687-701.

3 - Platt T. and Jassby A.D., 1976. The relationship between photosynthesis and light or natural assemblages of coastal marine phytoplankton. *J. Phycol.*, 12:421–30.

4 - Degobbis D., Precali R., Ivancic I., Smodlaka N., Fuks D. and Kveder S., 2000. Long-term changes in the northern Adriatic ecosystem related to anthropogenic eutrophication. *Int. J. Environ. Pollut.*, 13: 495-533.

SEASONAL DYNAMICS OF THE BACTERIAL COMMUNITY IN CORRELATION WITH DIFFERENT ENVIRONMENTAL FACTORS IN THE GULF OF TRIESTE (NORTHERN ADRIATIC)

Tinkara Tinta [1]* and Valentina Turk [1]
[1] National Institute of Biology, Marine Biology Station - tinta@mbss.org

Abstract
Seasonal dynamic of bacterial community was studied in the Gulf of Trieste (northern Adriatic). The bacterial abundance, productivity and community structure together with dissolved inorganic phosphate uptake by the ^{33}P orthophosphate incorporation method and nutrients factors were followed along the vertical profile. Preliminary analyses of bacterial community structure were performed.
Keywords: Adriatic Sea, Bacteria, Nutrients, Phosphorus

Introduction
The Gulf of Trieste, located in the Northern Adriatic sea, is a shallow, semi - enclosed basin, which oceanographic properties are strongly affected by water mass exchange from the Southern Adriatic, river inflows and meteorological conditions ([1]). Enrichment experiments proved that phosphorous is the primary limiting element for the growth of phytoplankton as well as for bacterioplankton in the Gulf of Trieste ([2]). Being an integral members of ecosystems, microbes are fundamental to the functioning and the health of the marine environment. Bacterial community abundance and productivity in the Gulf of Trieste has been studied in the past ([3]). However details of microbial processes in the Gulf of Trieste are still poorly understood. The aim of this study was to investigate in more details the seasonal dynamics of the bacterial community in correlation with different environmental factors in the Gulf of Trieste.

Material and methods
The seawater samples for chemical and biological parameters were collected during the period from 2007 to 2009 at standard sampling station, the oceanographic buoy, located in the middle of the Gulf of Trieste (northern Adriatic)**.** Sampling was performed biweekly at six different depths (1m, 3m, 5m, 10m, 15m and 20m) using a Niskin sampler. At the same time vertical distribution of temperature, salinity, chlorophyll *a* and dissolved oxygen was also determined using CTD probe. Samples were analyzed for nutrients, bacterial abundance and productivity as well as bacterial community structure. Bacterial abundance was determined according to standard protocol, by staining cells with 4',6-diamino-2-phenylindole (DAPI) and examining them under an epifluorescence microscope ([4]). Bacterial carbon production was measured by the incorporation of ^{3}H-leucine into newly synthesized proteins in the bacterial cells ([5]). Subsamples for nutrient analysis were filtered through glass fibre filters (GF/F) and analyzed according to standard protocols ([6]). Bacterial community structure was analyzed using two approaches: (i) by isolation of colony - forming bacteria on ZoBell media and (ii) by culture - independent genetic analysis. Subsamples for bacterial community structure analysis were obtained by filtering defined volume of unfixed seawater onto 0.2 µm polyethersulfonic PALL filters (25 mm diameter, PALL Inc.). DNA was extracted from the filters according to Böstrom ([7]) with slight modifications. Community fingerprints were determined using the denaturing gradient gel electrophoresis (DGGE).

Results and discussion
Bacterial abundance showed seasonal dynamics, with the highest values in the late spring - early summer period (6.5 x 10^8 cells L^{-1} in May) and at the beginning of the autumn period (9 x 10^8 cells L^{-1} in September). From the late autumn until the early spring we observed lower bacterial numbers and equal abundance distribution along the vertical profile. In the winter period and in the spring - early summer there were somehow higher values at the surface. On the other hand, in the late summer - early autumn period, the bacterial abundance was increasing towards the bottom of the water column. Bacterial carbon production showed seasonal dynamics as well, with the highest values measured in the summer (20 µg C L^{-1} day^{-1}) and lowest productivity in winter - early spring (5 µg C L^{-1} day^{-1}). From the late autumn to the early spring the productivity did not vary much along the vertical profile. From late spring until the middle of summer we observe higher bacterial productivity at the surface and at the bottom of the water column. At the end of the summer, on the other hand, the productivity at the surfaces in low, but increases with the depth, reaching the highest values at the bottom. Seasonally changes in dissolved inorganic phosphate uptake measured by the ^{33}P orthophosphate incorporation method were determined in total sea water and > 1 micrometer size fraction. Preliminary analyses of bacterial community structure were performed by sequencing dominate bacterial isolates and by determination of total community fingerprints using DGGE.

References
1 - Malacic V. and Petelin B., 2001. Gulf of Trieste in: Physical Oceanography of the Adriatic Sea, Past, Present and Future. Cushman-Roisin B, Gacic M, Poulain P M, Artegiani A (ed.), Kluwer Academic Press, Dordrecht, pp. 167-177.
2 - Malej A., Mozetic P., Turk V., Terzic S., Ahel M. and Cauwet G., 2003. Changes in particulate and dissolved organic matter in nutrient-enriched enclosures from an area influenced by mucilage: the northern Adriatic Sea. *J. Plankton Res.*, 25: 949-966.
3 - Turk V., Mozetic P. and Malej A., 2001. Seasonal variability in phytoplankton and bacterioplankton distribution in the semi-enclosed temperate gulf (Gulf of Trieste, Adriatic Sea). *Annales, Ser. hist. nat.*, 11: 53-64.
4 - Porter K. G. and Feig Y. S., 1980. The use of DAPI for identifying and counting aquatic microflora. *Limnol Oceanogr.*, 25: 943-948.
5 - Smith D. C. and Azam F., 1992. A simple, economical method for measuring bacterial protein synthesis rates in seawater using ^{3}H-leucin. *Mar. Microb. Food Webs*, 6: 107-114.
6 - Grasshoff K., Ehrhardt M. and Kremling K., 1983. Methods of seawater analysis. Verlag Chemie, Weinheim.
7 - Boström K. H., Simu K., Hagström A. and Riemann L., 2004. Optimization of DNA extraction for quantitative marine bacterioplankton community analysis. *Limnol. Oceanogr. Methods*, 2:365-373.

HIGH NITRATE SUPPLY INDUCES CHLOROPHYLL DEGRADATION *CHLORELLA* SP.

Inci Tüney [1], Dilek Unal [1]* and Atakan Sukatar [1]
[1] Faculty of Science Biology Dept., Ege University, Izmir, Turkey - dilek.unal@mail.ege.edu.tr

Abstract
The effects of high nitrate concentrations on chlorophyll degradation in *Chlorella* sp. were investigated. The decrease in the ratio of chlorophyll a/b with enrichment of high nitrate concentration (0.5 and 1 mM $NaNO_3$) was also caused by a decrease in chlorophyll a and an increase in chlorophyll b concentration in *Chlorella* sps. cultures.
Keywords: Algae, Chlorophyll-a, Nutrients, Pigments, Physiology

Introduction - Nutrient concentrations play an important role in the growth of phytoplankton, and the nitrogen sources considered most important for the growth of phytoplankton are nitrate and ammonium. Much higher nitrate concentrations have been found in aquatic ecosystems which were strongly contaminated by agricultural and urban activities [3], [1]. Enrichment of nitrogen and phosporus in aquatic enviroment can lead blooming of algae. Previously studies have also reported that nitrate could affect photosynthesis, growth and cellular toxicity of phytoplankton and metal toxicity to phytoplankton [3], [4], et [5]. Previosuly studied demostrated that excessive nitrogen fertilization causes osmotic stress, in which reactive oxygen species (ROS), hydrogen peroxide (H_2O_2) and hydroxyl radical (•OH) are produced [6]. ROS are highly toxic and can highly damage normal metabolism of lipids, proteins and nucleic acids and then inhibit plant and algae growth. Although, they found high nitrate concentration lead to inhibiton of growth of phytoplankton, effects of high nitrate stress on chlorophyll content, chlorophyll degradation and lipid peroxidation is still unexplored. In order to gain some insight into toxicity of nitrate in green algae, this study examined the effects of nitrate stress on chlorophyll degradation.

Material and Method - *Cultures and materials : Chlorella sp.* was obtained from EGEMAC culture collection, University of Ege, Izmir, Turkey. Eight flasks of 100 ml *Chlorella sp.* were used for the experiment. *Chlorella sp.* culture was grown photoautotrophically in Rudic Medium (RD) at 31°C in under continuous illumination (Table 1). Illumination provided by daylight fluorescence tubes at 20 µmol photons $m^{-2}s^{-1}$. Chlorella cells were harvested by centrifugation and transferred to a fresh medium, grown under the same conditions for 1 day; 0.05, 0.5 and 1 mM $NaNO_3$ were then added to the nitrate stress groups, respectively. The cultures were sampled 1, 3, 18, 24 and 44 h by removing 30 ml of the culture each time. All the experiments were repeated three times. Cell density was mesaured by spectrophotometer at 663 nm. About 20 mg cells was extracted in the dark for 1 h at 65 °C in 3 ml dimethyl sulfoxide (DMSO) in presence of polyvinylpolyrrolidone to minimize chlorophyll degradation. To assess chlorophylls, absorbance of the extracts was read at 665.1, and 649.1 nm. Statistical analysis was performed with one-way analysis of variance (ANOVA)(SPSS for Windows version 11.0).

Results and Discussion - Chlorophyll intermediate molecules are also potential chloroplast signals that could regulate photosynthetic gene expression, growth rates, and cell-death processes [7]. Our present results showed growth rate decrease closely correlated with decreasing chlorophyll a/b ratio following to supplemental different $NaNO_3$ concentration (Figure 1). Chlorophyll b is formed from chlorophyll a by the oxidation of the methyl group on ring II to the aldehyde and the ratio of chlorophyll a/b is more sensitive to modification than chlorophyll a+b. In green plants, antenna size is determined by the amount of light-harvesting chlorophyll a/b protein complex that is associated with the photosystems [7]. Conversion of chlorophyll b to chlorophyll a not only impacts the chlorophyll a/b ratio but also is the first step of chlorophyll degradation. In this study, on nutritional *Chlorella* sp. media and supplement 0.05 mM nitrate media, pigment levels were not significantly different (Table 1), but they did differ between groups in the presence of different nitrate concentration. The chlorophyll a/b ratio was significantly decreased in both 0.5 and 1 mM nitrate enrichment groups (Table 1). Our present results confirmed that supplemental $NaNO_3$ causes a significantly increase in chlorophyll b and a concomitant decrease in chlorophyll a, consistent with accelerated conversion of one to the other (Tab. 4). In conclusion, the levels of nitrate concentrations used in the present study ranged from 0.05 to 1 mM. According to the present study, these high nitrate concentrations caused chlorophyll degradation. Therefore, further research is required to investigate the effect of high nitrate concentrations on antioxidant mechanism in green algae. Table 1 shows Chlorophyll *a* /Chlorophyll *b* (Chl*a*/*b*) ratio of the alga Chlorella sp. cultivated with a nutritional level of nitrate (control) and nitrate supplement of 0.05, 0.5, and 1 mM.

Tab. 1. Values in bold are significantly different from control samples. Significance of differences ($p<0.05$) was checked by one-way analysis of variance (ANOVA). n=number of replicates, x=mean values, SD=standard deviations

Chla/b	n	1 h	3 h	18 h	24 h	44 h
		X±SD	X±SD	X±SD	X±SD	X±SD
Control	3	3,12±0.12	3,55±0.31	3,23±0.05	3,08±0.14	3,03±0.04
0.05 mM $NaNO_3$	3	3,84±0.27	3,30±0.13	2,97±0.24	2,83±0.34	3.32±0.23
0.5 mM $NaNO_3$	3	3,79±0.13	2,72±0.1	1,95±0.12	1,42±0.01	0.95±0.01
1 mM $NaNO_3$	3	3,60±0.12	2,47±0.27	0,97±0.06	0,88±0.02	0.53±0.13
ANOVA						
F probability		0.06	0.0003	0.0001	0.0001	0.0001

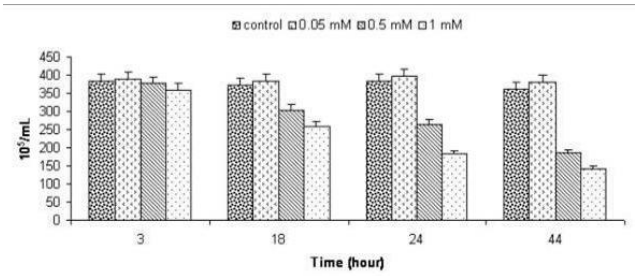


Fig. 1. Cell density of the alga Chlorella sp. cultivated with a nutritional level of nitrate (control) and nitrate supplement of 0.05, 0.5, and 1 mM.

References
1 - Pierce RH, Weeks JM., Prappas JM., 1993. Nitrate toxicity to five species of marine fish. *J World Aquacult Soc* 24:105-107.
2 - De Graaf F., 1964. Maintenance problems in large public aquaria. *Arch Neerland Zool.* 16:142-143
3 - Bates SS., Worms J., Smith JC., 1993. Effects of ammonium and nitrate on growth and domoic acid production by Nitzschia pungens in batch culture. *Can J Fish Aquat Sci.* 50:1248-1254
4 - Menéndez M., 2005. Effect of nutrient pulses on photosynthesis of Chaetomorpha linum from a shallow Mediterranean coastal lagoon. *Aquat Bot* 82:181–192.
5 - Rijstenbil JW, Dehairs F., Ehlich R., Wijnholds JA., 1998. Effect of the nitrogen status on copper accumulation and pools of metal-binding peptides in the planktonic diatom Thalassiosira pseudonana. *Aquatic Toxicol.* 42:187-209.
6 - Zhang GW., Liu ZL., Zhou JG., Zhu YL., 2008. Effects of $Ca(NO_3)_2$ stress on oxidative damage, antioxidant enzymes activities and polyamine contents in roots of grafted and non-grafted tomato plants. *Plant Growth Regul.* 56:7-19.
7 - Tanaka A., Tanaka R., 2006. Chlorophyll metabolism; a review. *Current Opinion in Plant Biology* 9:248-255.
8 - Viaroli P, Bartoli M, Bondavalli C, Naldi M (1995) Oxygen fluxes and dystrophy in a coastal lagoon colonized by Ulva rigida (Sacca di Goro, Po River Delta, northern Italy). Fresenius Environ Bull 4:381–386
9 - Herndon J, Cochlan WP (2007) Nitrogen utilization by the raphidophyte Heterosigma akashiwo: growth and uptake kinetics in laboratory cultures. Harmful Algae 6:260–270.
10 - Rouse JD., Bishop CA., Struger J 1999. Nitrogen pollution: an assessment of its threat to amphibian survival. Environ health perspect 107:799-803

THE DEGRADATION OF DIFFERENT SCYHPOZOAN JELLYFISH SPECIES BY THE AMBIENT BACTERIAL COMMUNITY

Valentina Turk [1]*

[1] National Institute of Biology, Marine Biology Station - turk@mbss.org

Abstract

The chemical composition and degradation of dead jellyfish tissue of *Aurelia* sp., *Pelagia noctiluca* and *Rhizostoma pulmo* by the ambient bacterial community was studied in laboratory experiments using samples from the Gulf of Trieste (northern Adriatic). Preliminary results showed rapid hydrolyzes of proteins in the presence of the natural microbial community and significant release of disolved and anorganic nutrients, which can significantly alter the carbon and nitrogen cycles and oxygen dynamics in the surrounding environment.

Keywords: Adriatic Sea, Bacteria, Medusae, Nutrients, Organic Matter

Introduction

The increasing frequency and intensity of jellyfish outbreaks in the northern Adriatic may have a significant impact on fisheries, tourism and the functioning of the food web. Although eight scyphomedusae species have been discovered over the last 150 years in the northern Adriatic, only a few, have been observed in large numbers [3]. The total organic content of jellyfish is 1-2 % of wet weight and generally consists of high protein (72±14 %) contents, low carbohydrate (7±5 %) and lipid (22±12 %) contents [4]. Proteins, as a quantitatively important component of the jellyfish body, are substantially organic-nitogen containing compounds believed to be very labile. During the decomposition of blooms, jellyfish carcasses can serve as an important source of protein to the environment. Few studies have addressed the fate of dead jellyfish [6], [8] nor indicated rapid decomposition and nutrient release, either in the water column or on the sediment surface.

Materials and method

Jellyfish for our experiments were collected by dip net from the surface during bloom events in the Gulf of Trieste (northern Adriatic). Bell diameters and wet weight were measured for each jellyfish. Seawater samples were collected with a Niskin sampler at 3 m depth at station BF (45° 32.804 N; 13° 33.034 E) in the Gulf of Trieste. Immediately after sampling, seawater was filtered through a 200 µm mesh net and subsequently through GF/F filters (Whatman) to yield a filtrate containing microorganisms. The filtered seawater was collected in 8 L acid washed and autoclaved polycarbonate bottles (Nalgen) and was used for the jellyfish decomposition experiments. In each experiment equal amounts of jellyfish were selected and their whole tissues, including interstitial water, homogenized with an Ultra – Turrax TP 18/10 (Janke & Kundel) at 20 000 rpm for several minutes. The whole tissue of each jellyfish was used as substrate, diluted in 8 litres of pre-filtered sea water containing the ambient bacterial community. Bottles with filtered sea water without addition of jellyfish served as controls. The bottles were incubated *in situ* at 3m depth in front of the Marine Biology Station from 24 March to 15 April 2009. Part of the homogenate was frozen and stored for CHNS elemental analysis. All nutrient analyses were performed on a GF/F pre-filtered water sample, using the standard protocols ([2]) and protein concentrations were determined by the Bradford method [1] using the Bio Rad Protein Assay Kit. Dissolved oxygen (DO) concentration was measured in triplicate by the standard Winkler method. Bacterial abundance was determined according to standard protocol, by staining cells with 4',6-diamino-2-phenylindole (DAPI) and examining them under an epifluorescence microscope [5]. Bacterial carbon production was measured by the incorporation of ^{3}H-leucine into newly synthesized proteins in the bacterial cells [7]. Bacterial community structure was analyzed using two approaches: (i) by isolation of colony - forming bacteria on ZoBell media and (ii) by culture-independent analysis using the denaturing gradient gel electrophoresis (DGGE) fingerprinting method.

Results and discussion

Elemental analysis of *Aurelia* sp., *Pelagia noctiluca* and *Rhizostoma pulmo* reveals low dry weight specific carbon and nitrogen content, and rather low C/N atomic ratios (3.9 – 4.9). Preliminary results showed variation in protein concentrations of added dead substrate between jellyfish species. Concentrations were twice as high in the experimental bottles with *Pelagia* and *Rhizostoma* compared with *Aurelia*. After 72 hours of incubation, the protein concentrations were reduced in all experimental bottles with the jelly-mixture, and significant bacterial growth with biomass increases was recorded. The initially high concentrations of protein, DOP and orthophosphate in the amended bottles, appear to support microbial mineralizations which consume oxygen and release dissolved inorganic nutrients, mainly ammonium. The rate of degradation and bacterial growth depends on jellyfish chemical composition as indicated by the ratio of biomass, ammonium and phosphate accumulation of 1:3 between *Aurelia* and *Pelagia.*

References

1 - Bradford M. M., 1976. A rapid and sensitive method for the quantification of microgram quantities of protein utilizing the principle of protein-dye binding. *Analytical Biochemistry* , 72: 248–254.

2 - Grasshoff K., Ehrhardt M. and Kremling K., 1983. Methods of seawater analysis. Verlag Chemie, Weinheim.

3 - Malej A., 2001. Are irregular plankton phenomena getting more frequent in the northern Adriatic Sea? CIESM 2001 Gelatinous zooplankton outbreaks: theory and practice. CIESM Workshop Series, Monaco, No 14, pp. 112

4 - Pitt K. A., Welsh D. T. and Condon R. H., 2009. Influence of jellyfish blooms on carbon, nitrogen and phosphorous cycling and plankton production. *Hydrobiologia*, 616: 133–149.

5 - Porter K. G. and Feig Y. S., 1980. The use of DAPI for identifying and counting aquatic microflora. *Limnol. Oceanogr.*, 25: 943-948.

6 - Titelman J., Riemann L., Sørnes T. A., Nilsen T., Griekspoor B. and Båmstedt U., 2006. Turnover of dead jellyfish: stimulation and retardation on microbial activity. *Marine Ecology Progress Series*, 325: 43–58.

7 - Smith D. C. and Azam F., 1992. A simple, economical method for measuring bacterial protein synthesis rates in seawater using ^{3}H-leucin. *Mar. Microb. Food Webs*, 6: 107-114.

8 - West E. J., Welsh D. T. and Pitt K. A., 2009. Influence of decomposing jellyfish on the sediment oxygen demand and nutrient dynamics. *Hydrobiologia*, 616: 151–160.

EMILIANIA HUXLEYI BLOOM IN WINTER PERIOD IN THE DARDANELLES, TURKEY

Muhammet Türkoglu [1]*
[1] Yes - mturkoglu@comu.edu.tr

Abstract

Following a strong summer bloom of *Emiliania huxleyi* (Lohmann) Hay & Mohler, 1967 in June and July 2003, a winter bloom was observed for the first time between late December 2003 and early January 2004 in the Dardanelles and the results were appreciated along with hydrography. *E. huxleyi* was the dominant species and represented about 90.0% of the phytoplankton assemblage. The bloom started flourishing after the diatom and dinoflagellate blooms under nitrogen depleted and moderate light, temperature and salinity conditions.

Keywords: Dardanelles, Blooms, Coccolithophores, Hydrography

The Dardanelles is a part of the Turkish Strait System and located between the Aegean Sea and the Sea of Marmara and has two flow system reverse to one another [1]. The data in this study is a part of the data collected during cruises in the period of January 2002 and January 2004, in the framework of a National project of TUBITAK, Turkey [1]. CTD parameters, nutrient and chlorophyll-a were also measured by using YSI 6600 MPS, Autoanalizor and spectrophotometer, respectively [2]. Except for the polar ones, *E. huxleyi* is one of the most abundant coccolithophores occurring globally in the oceans in early summer periods. In summer, high surface irradiance, shallow stratification with a mixed layer depth of about 10-20 m, anomalies in salinity and temperature, low phosphate and silicate concentrations compose favorable conditions for *E. huxleyi* bloom in the marine systems [3]. However, following a strong summer bloom of coccolithophore in June and July 2003 [3], a winter bloom was observed for the first time between late December 2003 and early January 2004 in the Dardanelles (Fig. 1).

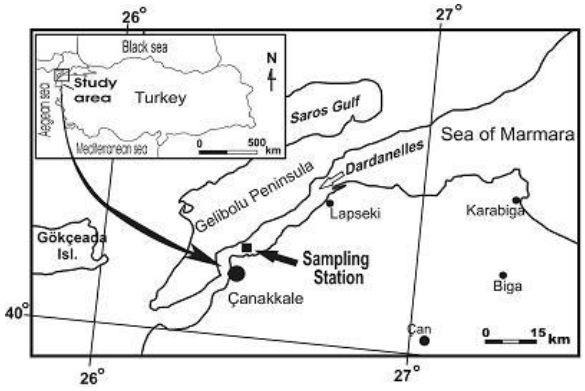


Fig. 1. Map of the Dardanelles and sampling station

While *E. huxleyi* revealed small population density (1.60 x 10^4 cells L^{-1}) in early December 2003, the bloom started in middle December 2003 (7.86 x 10^6 cells L^{-1}) and then peaked in early January 2004 (5.03 x 10^7 cells L^{-1}) in the superficial layer. The peak dramatically decreased in late January 2004 (7.50 x 10^6 cells L^{-1}) (Fig. 2A). *E. huxleyi* was the dominant species and represented about 90.0% of the phytoplankton assemblage. The bloom started flourishing after the diatom and dinoflagellate blooms (Figs. 2B, C) under nitrogen depleted and moderate light, temperature and salinity conditions. Water temperature (10.31±1.14 ^oC) and salinity values (27.05±0.88 ppt) were usually stabile. Surface chlorophyll-a concentrations ranged from 1.23 to 2.32 µg L^{-1} (1.94±0.43 µg L^{-1}) during the bloom (Fig. 2E). Vertical profiles of inorganic nutrients showed that the concentrations in the upper layer were lower (0.26±0.14 µM for NO^-_2+NO^-_3, 0.06±0.01 µM for PO^{-3}_4 and 2.51±1.16 µM for SiO_4 than those in the lower layer (0.42±0.24 µM for NO^-_2+NO^-_3, 0.07±0.02 µM for PO^{-3}_4 and 2.80±0.84 µM for SiO_4) due to *E. huxleyi* blooms in the surface waters during the winter bloom conditions. Although SiO_4 concentration was calculated as mean value of 2.80±0.84 µM, the surface concentration was lower than 2.00 µM in the first period of the *E. huxleyi* bloom, due to its excessive utilization by diatoms just before the *E. huxleyi* bloom (Figs. 2A, C). Ratios of N:P (min-max: 2.00-7.33; mean:4.12±2.12,) Si:N (min-max: 3.08-17.33; mean: 9.79±4.32) and Si:P (min-max: 24.00-58.50; mean: 40.35±16.25) of the bloom period were lower than those of the non bloom periods. The strong bloom potential of *E.huxleyi* in winter period in addition to the summer period [3] has revealed that the Dardanelles is under the hyper-eutrophication due to the fact that it is a part of the Turkish Strait System affected by the Black Sea.

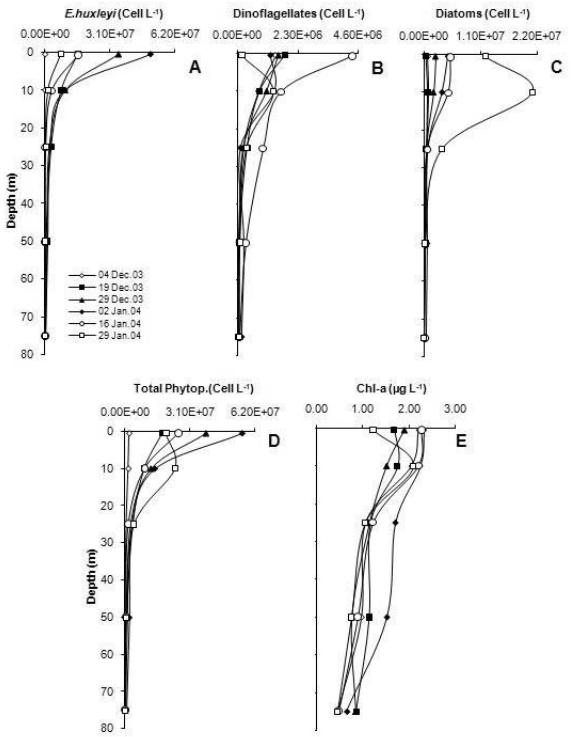


Fig. 2. The vertical profiles of E. huxleyi (A), dinoflagellates (B), diatoms (C), total phytoplankton (D), and chlorophyll-a (E) in winter in the Dardanelles

Acknowledgements : This study is funded by TUBITAK Project # 101Y081. This study has also been accepted as more detailed research article in "Hydrology Research (Formerly Nordic Hydrology)". Please look at the journal for more detailed information and discussion.

References

1 - Turkoglu, M., Unsal, M., Ismen, A., Mavili, S., Sever, T.M., Yenici, E., Kaya, S., Coker, T., 2004. Dinamics of lower and high food chain of the Dardanelles and Saros Bay (North Aegean Sea). TUBITAK Final Report, 101Y081, Çanakkale, Turkey.

2 - Strickland, J.D.H. and Parsons, T.R., 1972. A Practical handbook of seawater analysis, 2nd ed. Canada.

3 - Turkoglu, M., 2008. Synchronous blooms of the coccolithophore Emiliania huxleyi (Lohmann) Hay & Mohler and three dinoflagellates in the Dardanelles (Turkish Straits System). *Journal of the Marine and Biological Association of the United Kingdom*, 88 (3): 433-441.

SHORT TIME VARIATIONS OF CHLOROHYLL A AND NUTRIENTS IN THE DARDANELLES, TURKEY

Muhammet Türkoglu [1]*
[1] Yes - mturkoglu@comu.edu.tr

Abstract
The distribution of chlorophyll a and nutrients were investigated in relation to the hydrography in the period of January 2002 and January 2004 in the Dardanelles. Nutrient levels were lower in the upper layer waters than in the lower layer waters due to excessive algal blooms in the surface waters. In vision of nutrient ratios (N:P=3.21, Si:P=33.17 and Si:N=12.71), nitrate was more limiting nutrient than phosphate. In addition to high chlorophyll a levels in surface waters (3.01±2.83 µg L^{-1}), there were secondary high values of chlorophyll a in subsurface depths especially in spring and summer periods.
Keywords: Dardanelles, Chlorophyll-a, Nutrients, Hydrography, Time Series

The distribution of phytoplankton chlorophyll a and inorganic nutrients were investigated along with hydrography in just nouthern part of the Nara Cape of the Dardanelles (Fig. 1).

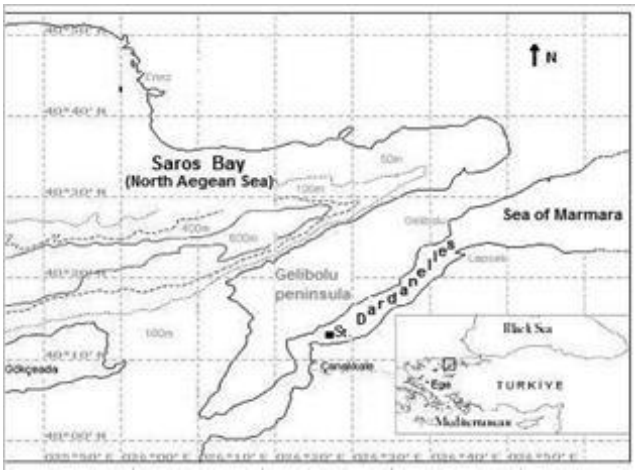


Fig. 1. Map of the Dardanelles (Çanakkale Strait) and sampling station (St.)

The Dardanelles is located between the Aegean Sea and the Sea of Marmara and has two flow system reverse to one another [1]. The data were collected during cruises in the period of January 2002 and January 2004, in the framework of a National project of TUBITAK, Turkey [1]. It was collected 74 surface samples for chlorophyll a and nutrient during the two years sampling period. CTD parameters, nutrient and chlorophyll a were measured by using YSI 6600 MPS, Autoanalizor and spectrophotometer, respectively [2]. Results showed that temporal temperature variations in surface waters (6.25-25.99 °C) originated from the Black Sea were higher than deep waters (13.09-18.44 °C) originated from Mediterranean. Due to two different water systems, there were two temperature stratification reverse to one another during the year. Since surface water of the Dardanelles was affected by the Black Sea, there was a vertical salinity profile increasing with depth (from 22.28-26.95 to 38.09-38.93 ppt) during the year. Dissolved oxygen in surface waters were generally close to saturation limit (10 mg L^{-1}) and sometimes were higher than the limit (>10 mg L^{-1}). Due to excessive algal blooms in the surface waters [1], surface levels of nutrients were lower (0.21±0.22 µM for NO^{-}_{2}+NO^{-}_{3}, 0.08±0.05 µM for PO^{-3}_{4} and 1.80±1.14 µM for SiO_4) than deep levels (0.50±0.35 µM for NO^{-}_{2}+NO^{-}_{3}, 0.08±0.06 µM for PO^{-3}_{4} and 2.80±0.97 µM for SiO_4) except for PO^{-3}_{4} (Fig. 2). Elemental ratios of N:P, Si:P and Si:N were calculated to be 3.21±2.70, 33.17±34.47 and 12.71±11.52 in surface waters respectively, whereas they were calculated to be 6.66±5.92, 38.40±19.86 and 8.76±7.14 in deep waters respectively. In vision of the elemental ratios, nitrate was more limiting nutrient than phosphate. Chlorophyll a ranged from 0.13 to 15.21 µg L^{-1} (3.01±2.83 µg L^{-1}) in surface waters. In addition to high chlorophyll a levels in surface waters, there were secondary high values of chlorophyll a (min-max: 0.47-16.16; mean: 3.18±3.02 µg L^{-1}) in subsurface layer waters (10 m) in some periods, especially in spring and summer periods (Fig. 2).

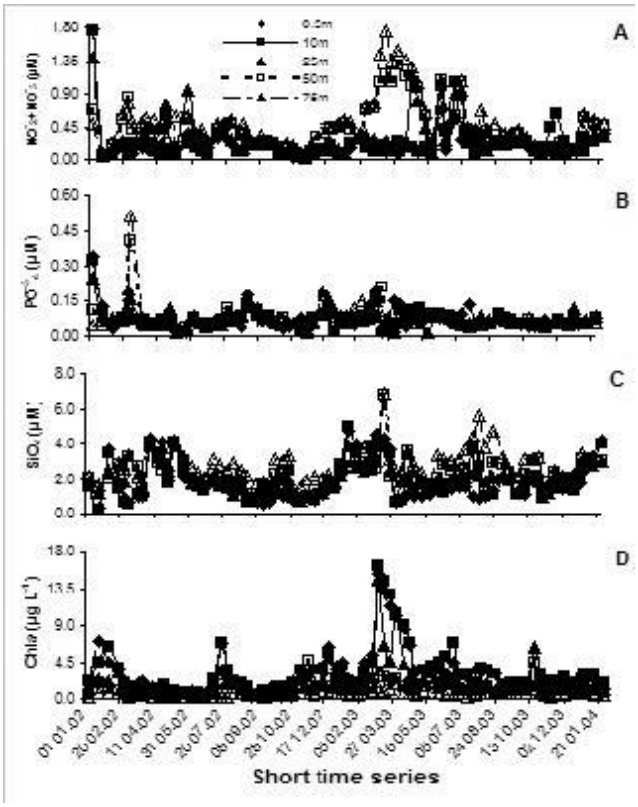


Fig. 2. Short time variations of nutrients and chlorophyll a in the Dardanelles (Çanakkale Strait)

At sight of high levels of nutrients and chlorophyll a, Dardanelles is under the heavy eutrophication due to the fact that it is a part of the Turkish Strait System affected by the Black Sea.

References
1 - Turkoglu, M., Unsal, M., Ismen, A., Mavili, S., Sever, T.M., Yenici, E., Kaya, S., Coker, T. 2004. Dinamics of lower and high food chain of the Dardanelles and Saros Bay (North Aegean Sea). TUBITAK Final Report, 101Y081, Ç.kale, Turkey.
2 - Strickland, J.D.H. and Parsons, T.R., 1972. A Practical handbook of seawater analysis, 2nd ed. Canada.

VIRUS-PROKARYOTE-NANOFLAGELLATE-MICROZOOPLANKTON INTERACTIONS IN SURFACE WATERS OF THE MEDITERRANEAN SEA.

S. F. Umani [1]*, C. Blason [1], E. D. Poi [1], E. Malisana [1], C. Corinaldesi [2] and R. Danovaro [2]
[1] Department of Life Sciences, University of Trieste - s.fonda@units.it
[2] Department fo Marine Sciences, Polytechnic University of Marche

Abstract

To understand the relative importance of viral shunt *vs* predation of both heterotrophic nanoplankton (HNF) and microzooplankton on autotrophic and hetereotrophic prokaryotes in the pelagic Mediterranean food web, we performed a series of independent incubation experiments along a wide trophic gradient from the Atlantic Ocean to the eastern Mediterranean Sea during a trans-Mediterranean cruise (May-June 2007). Results indicate that nanoflagellates predation, although often strongly controlled by microzooplankton, caused most prokaryotic losses; microzooplankton was more efficient on the autotrophic picoplankton.

Keywords: Bacteria, Predation, Levantine Basin, Western Mediterranean, Plankton

Surface water samples were collected at 9 stations including: 1 station in the Atlantic Sea (station VA), 4 stations in the western Mediterranean Sea and 4 stations in eastern Mediterranean Sea (fig.1).

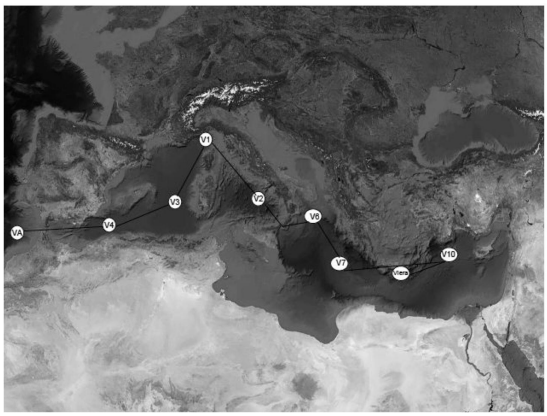


Fig. 1. Position of the 9 stations along the cruise track (VECTOR Project May-June 2007).

The loss of prokaryotic biomass caused by grazing or virus-mediated lysis has different consequences in organic C fluxes and biogeochemical cycles. If the main control of prokaryotic abundance is via protozoan grazing, most of the carbon will be channelled to higher trophic levels in the food web. Conversely, if viral infection accounts for most prokaryotic losses, the flow of carbon and nutrients can be diverted away from larger organisms thus accelerating the transformation of nutrients from particulate to dissolved states. This last process is named "viral shunt". The impact of viruses in pelagic processes depends largely on the significance of the virus-induced prokaryote mortality (VIPM). In the present study VIPM has been estimated on the basis of the viral production and the burst size of viruses (i.e, number of viruses released per infected cell). Viral production rates were measured using the dilution approach, which has been repeatedly applied to several coastal and deep-sea systems [1, 2]. Results reported here indicate that viral abundance was very low and did not significantly vary along the trophic gradient (on average, 6.94×10^4 viruses mL^{-1}). Conversely viral production ranged from $1.16 \pm 0.16 \times 10^3$ viruses $mL^{-1}h^{-1}$, at the station V1, to $2.57 \pm 0.60 \times 10^4$ viruses $mL^{-1}h^{-1}$, at the station V3, in the western Mediterranean Sea. However, on average, no significant differences were observed between viral production in western and eastern Mediterranean Sea. Assuming a burst size of 15, the fraction of prokaryotes killed by viruses per day ranged from ca. 0.3 to ca. 8% d^{-1} (at the stations V1 and V3, in the western Mediterranean Sea) and on average similar values of prokaryotic mortality were observed in both western and eastern sectors of the Mediterranean Sea. Previous studies suggested that higher values of VIPM may be related to the probable absence, or extremely low density, of grazers that compete with viruses for prokaryotic cells [2]. In the present study nanoflagellates (HNF) abundance (range: 3.63 ± 1.18 x10^2 - 1.15 ± 0.05 x10^3 individuals L^{-1}) was on average 2 orders of magnitude lower than viral abundance (fig. 2). A positive relationship (n = 9 R = 0.74) was observed between viruses to HNF abundance ratio and VIPM suggesting a higher contribution of the viral infection to prokaryotic mortality with decreasing HNF abundance. Heterotrophic bacteria abundance (fig.2) ranged from 2.44 ± 7.8 to 6.57 ± 3.45 x10^5 cells L^{-1}, and on average was higher in the western basin. Microzooplankton (MZ) abundance (fig.2) ranged from 7.64 ± 1.36 to 20.08 ± 4.34 x10^2 individuals L^{-1}.

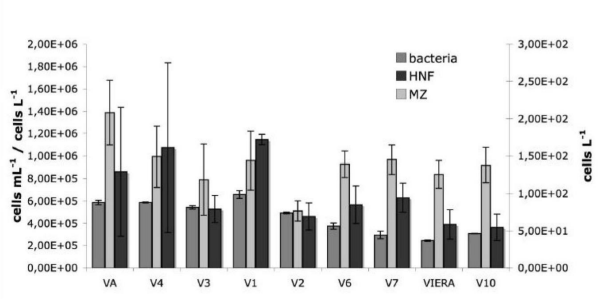


Fig. 2. Abundance of heterotrophic picoplankton and nanoplankton, and microzooplankton in the 9 stations of the trans.Mediterranean cruise.

Grazing impact of HNF and MZ on picoplankton was separately assessed using the classic Landry and Hasset (1982) [3] dilution method. Four models of interaction between HNF and MZ were identified: 1) only HNF fed on picoplankton, no MZ grazing was detected on both picoplankton and HNF, 2) MZ fed directly on picoplankton, no HNF predation was detected, 3) MZ caused an increase in prokaryotic loss compared to the only HNF predation, indicating a direct predation of larger consumers, 4) MZ grazing on HNF reduced prokaryotic biomass loss, indicating a strong top down control of MZ on HNF biomass. The experiments of HNF grazing indicated that most of the prokaryotic mortality in surface waters of the Mediterranean Sea is due to predation by HNF, although in few cases, and particularly on autotrophic fraction, MZ was a more efficient predator than HNF. Results show that in the eastern Mediterranean picoplankton mortality due to both HNF and MZ grazing was always higher than growth rate.

References

1 - Hewson, I. & Fuhrman, J.A., 2003. Viriobenthos production and virioplankton sorptive scavenging by suspended sediment particles in coastal and pelagic waters. *Microb. Ecol.*, 46: 337–347.

2 - Corinaldesi, C., Dell'Anno, A., Danovaro, R., 2007. Viral infection plays a key role in extracellular DNA dynamics in marine anoxic systems. *Limnol. & Oceanogr*. 52: 508-516.

3 - Landry, M.R., Hasset, R.P., 1982. Estimating the grazing impact of marine Microzooplankton. *Mar. Biol*., 67: 283–288.

NOVEL APPROACHES TO MOLECULAR DIAGNOSTICS OF *PROROCENTRUM MINIMUM* IN THE GOLDEN HORN ESTUARY, THE SEA OF MARMARA

I. Uzonur [1]*, F. Koyuncu [1], S. Tas [2], Z. Ulupinar [1] and E. Muftuoglu [2]
[1] Fatih University, Biology Department - iuzonur@fatih.edu.tr
[2] Istanbul University, Institute of Marine Sciences and Management, Physical Oceanography and Marine Biology Department, Istanbul, Turkey

Abstract
The identification and quantification of individual algal species remains difficult, time consuming, requiring a great deal of expertise and experience. Alternative to traditional, morphology-based methods, molecular techniques need less expertise for the detection of cryptic species within the bioindicator community. Although these methods require detailed knowledge of the molecular diversity within taxa in order to design efficient specific primers to avoid cross-reaction with non-target sequences. Based on rDNA (large subunit) LSU, RAPD and real-time PCR results and melting curve analysis, a model system to detect marine, planktonic, bloom -forming dinoflagellate *Prorocentrum minimum* using the DNA extracted from the Golden Horn Estuary bloom samples and mixed samples.
Keywords: Bio-Indicators, Toxic Blooms, Population Dynamics, Phytoplankton, Bosphorus

Introduction
DNA directly amplified from the environment have revealed a rich biodiversity of marine dinoflagellates that has escaped routine detection using microscopy [1]. The rDNA amplification approach to explore for the presence of unknown dinoflagellate DNA in the marine environment includes dinoflagellate-specific PCR of DNA extracted from field samples and cloning and sequence analysis of randomly selected clones [2]. DNA melting curve analysis is a technique that can be applied post-PCR to provide the melting temperature of the amplification products [3]. Sequence differences of each PCR amplicon can be distinguished by the melting curve that is affected by the GC content of the PCR product and the absolute order of the bases in the sequence [4, 5].

Materials and Methods
Field samples used in this work are morphologically identified dinoflagellate *Prorocentrum minimum* obtained from Golden Horn 26.07.2000 bloom. The number of cells were counted to be $70x10^6$/lt [6]. DNA isolation was done using MN Nucleospin Plant II kit. The sequences of the primers are given in Table 1. For real-time PCR Takara's SYBR Premix Ex Taq kit has been used. Real-time PCR has been done in Rotorgene Thermal Cycler. Confirmation of the real-time results were done on 2% Agarose gels (Figure 1). The size markers used in gel electophoresis have the band sizes 1000bp, 900 bp, 800 bp, 700 bp, 600 bp, 500 bp, 400 bp, 300 bp, 200 bp and 100 bp in descending order.

Results and Discussion
Instabilities in the aquatic ecosystem should be monitored routinely. There are some bioindicator species that can be biomonitored for red-tide events in the Sea of Marmara. *Prorocentrum minimum* is a toxic species causing frequent red-tides especially in Haliç. In our study we have done the detection of this bioindicator species by using real-time PCR as a supporting tool for conventional methods of detection which will facilitate the routine monitoring of this species in the Sea of Marmara. Our approach, using the polymerase chain reaction (PCR) amplification of large subunit gene sequences (LSU rDNA), *P. minimum* specific sequences and RAPD and sybrgreen RAPD-real-time PCR is a useful and cost-effective genotyping method that can be used to determine both the population complexity and species identification of organisms in harmful algal blooms [7, 8]. DNA fragments (represented as bands on the gel) that were excised from agarose gel and were sequenced to determine the genetic variation data due to spontaneous mutations or taxonomic differences among the various bloom forming *Prorocentrum minimum* clones. There seems to be intra-specific variation, although spatial and temporal origins of the Haliç bloom samples was the same and approximately 100% cells as biomass and diversity belong to *P. minimum* [6]. Melting temperature differences are indicating this well and the xn PCR data confirmation with 2%agarose gel electrophoresis figures are indicating the variation as formed polymorphic bands and heteroduplexes detected and shown with arrows in figures confirmed with the sequencing data. x10 real-time LSU-rDNA amplification confirmation of Haliç 2000 *Prorocentrum minimum* bloom DNA indicating the dimorphism in the amplicon.

Tab. 1. Reproducible Tm peak ranges (C) after melting curve analysis for LSU rDNA and for species

Name	Primer Sequence (5'→3')	Specification/Amplicon size	Reproducible Tm peak ranges (°C) after melting curve analysis
LSU-D1R	5'-ACC CGC TGA ATT TAA GCA TA-3'	650-850 bp	87.0-87.7
LSU-D2C	5'- CCT TGG TCC GTG TTT CAA GA-3'	650-850 bp	
Minimum F	5'-GGG TCA TGG TAG CTC GTC TA-3'	165 bp	87.2-88.5
Minimum R	5'-CGT CTT TGT GTC AGG GAA AT-3'	165 bp	

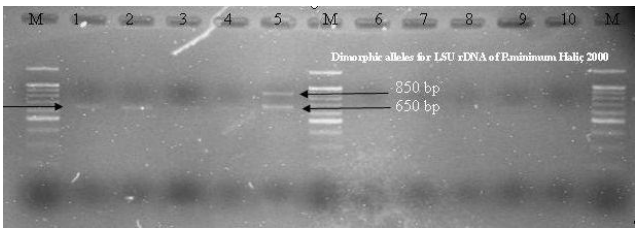


Fig. 1. X10 real-time LSU-rDNA amplification confirmation of Haliç 2000 *Prorocentrum minimum* bloom DNA indicating the dimorphism in the amplicon

References
1 - Lopez-Garcia, P., Rodriguez-Valera, F., Pedros-Allo, C., Moreira, D., (2001). Unexpected diversityof small eukaryotes indeep-sea Antarctic plankton. Nature 409,603–607.
2 - Lakeman, M. B., P. von Dassow, et al. (2009). "The strain concept in phytoplankton ecology." Harmful Algae 8(5): 746-758.
3 - Robinson, B.S., Monis, P.T., Dobson, P.J., (2006). Rapid, sensitive, and discriminating identification of Naegleria spp. by real-time PCR and melting-curve analysis. Appl. Environ. Microbiol. 72, 5857–5863
4 - Monis, P.T., Giglio, S., (2006). Nucleic acid amplification-based techniques for pathogen detection and identification. Infect. Genet. Evol. 6, 2–12.
5 - Park, T., Park, G., Park, Y., Kang, Y., Bae, H., Kim, C., Jeong, H., Lee, Y., (2009) "Identification of the dinoflagellate community during Cochlodinium polykrikoides (Dinophyceae) blooms using amplified rDNA melting curve analysis and real-time PCR probes" Harmful Algae 8 430–440.
6 - Tas, S.,Yilmaz, I. N., Okus, E. (2009). Phytoplankton as an Indicator of Improving Water Quality in the Golden Horn. Estuary Estuaries and Coasts DOI 10.1007/s12237-009-9207-3.
7 - Sonnenberg, R., A. W. Nolte, et al. (2007). "An evaluation of LSU rDNA D1-D2 sequences for their use in species identification." Front Zool 4: 6.
8 - Scorzetti, G., L. E. Brand, et al. (2009). "Multiple simultaneous detection of Harmful Algal Blooms (HABs) through a high throughput bead array technology, with potential use in phytoplankton community analysis." Harmful Algae 8(2): 196-211.

LONGITUDINAL AND VERTICAL TRENDS OF BACTERIAL PRODUCTION AND HIGH AND LOW NUCLEIC-ACID BACTERIOPLANKTON CELLS IN MEDITERRANEAN SEA

F. Van Wambeke [1]*, A. Talarmin [1], P. Catala [2], P. Lebaron [2], C. Courties [3] and T. Moutin [4]
[1] CNRS, Université de La Méditerranée LMGEM, UMR 6117, Marseille, France - france.van-wambeke@univmed.fr
[2] CNRS, Université Paris06, OOB, UMR 7621, Banyuls-sur-mer, France
[3] CNRS, Université Paris06, OOB, UMS 2348, Banyuls-sur-mer, France
[4] CNRS, Université de la Méditerranée, LOPB, UMR CNRS 6535, Marseille, France

Abstract
The cytometric characteristics (Size Scatter and Green Fluorescence) and abundances of HNA (high nucleic acid) and LNA (low nucleic acid) bacterioplankton cells were examined in the frame of a Transmediterranean cruise held in summer 2008. LNA and HNA group showed remarkable distribution following vertical, chlorophyll and bacterial production gradients.
Keywords: Bacteria, Open Sea, Organic Matter, Competition

In the last decade there has been an increasing documentation on the relationship between key bacterioplankton groups and their role in the heterotrophic bacterial production. Mediterranean Sea being strongly stratified and P limited during a large part of the year, P limitation of heterotrophic bacterial production is not uncommon. In the frame of French (BOUM : biogeochemistry from oligotrophy to ultra-oligotrophy of the Mediterranean Sea) and EU programs (SESAME: Southern European Seas, Assessing and Modelling Ecosystem changes) we examined bacterial production over different basins, with the attempt to focus on the role played by high and low nucleic acid groups (HNA and LNA groups, respectively) in relation to surrounding biogeochemical conditions. Most studies dealing on HNA and LNA after flow cytometry analysis focused mainly on their abundance distribution. Investigations using ^{3}H-leucine labelling coupled to cell sorting technique, since the pioneer study by Servais et al (1999), suggested the importance of HNA group to sustain bacterial production, these cells being not only larger but also more active per unit cell than LNA cells. However, in oceanic areas, the role of LNA to sustain a large part of bacterial production has been also evidenced [1], [2] et [3]. Flow cytometry allows also determination of other HNA and LNA group characteristics: Size Scatter (SSC) and green fluorescence (FL). Recently, it has been suggested that interactions within these two groups could be highly dynamics [1] and partly explained by the relationships between the cytometric characteristics of these 2 groups. However, although these 2 fractions are ubiquitous in aquatic systems, little is known about their distribution in the oligotrophic to ultraoligotrophic Mediterranean Sea, and nothing about their cytometric characteristics. Both HNA and LNA abundances increased with bacterial production, however the slope of increase of HNA being lower than that of LNA, the percentage of HNA slowly decreased when bacterial production increased (Figure 1). The cytometric characteristics of these 2 groups exhibited different types of relations according vertical distribution of chlorophyll, notably distinct groups emerged for layers above the deep chlorophyll maximum (dcm), below the dcm and for deep layers (-250 m). ^{3}H-leucine labelling coupled to cell sorting enabled us to reveal the distribution of high and low nucleic acid groups within heterotrophic bacterioplankton in terms of leucine assimilation and response to amendments, as well as the potential of some cyanobacteria to assimilate organic compounds. HNA cells responded drastically after nitrogen+phosphorus enrichments by both increasing their abundance, their contribution in term of total abundance but also their per cell activity, with a final contribution of total BP reaching 86%, demonstrating its zymogenous-type behaviour. However for in situ steady state conditions of oligotrophy, HNA cells exhibited large variability of per cell activity according to the cell size, the low size HNA group exhibiting the same per cell activity than LNA cells. LNA cells were abundant within the surface layers (41 to 74 % of abundances) and their bulk activity could be responsible of up to 65 % of the total bacterial production.

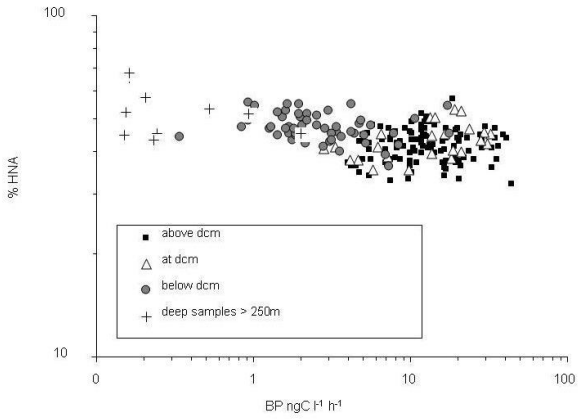


Fig. 1. Relationship between the proportion of HNA cells and the bacterial production over vertical and horizontal gradient in the Mediterranean Sea. Distinct groups were identified according vertical distribution of chlorophyll a

References
1 - Bouvier T., Del Giorgio P. and Gasol J., 2007. A comparative study of the cytometric characteristics of high and low nucleic acid bacteriaoplankton cells from different aquatic ecosystems. *Environ. Microbiol.*, 9:2050-2066
2 - Scharek R. and Latasa M., 2007. Growth, grazing and carbon flux of high and low nucleic acid bacteria differ in surace and deep chlorophyll maximum layers in the NW Mediterranean Sea. *Aquat. Microb. Ecol.*, 46:153-161
3 - Moran X.A., Bode A., Suarez L.A. and Nogueira E., 2007. Assessing the relevance of nucleic acid content as an indicator of marine bacterial activity. *Aquat. Microb. Ecol.*, 46:141-152
4 - Servais P., Courties C., Lebaron P. and Trousselier M., 1999. Coupling bacterial activity measurements with cell sorting by flow cytometry. *Microb. Ecol.*, 38:180-189

POTENTIAL TOLL OF A DESALINATION PLANT: B) THE MICROBIAL ASPECT

Yosef Yacobi [1]* and Nurit Kress [1]
[1] Israel Oceanographic and Limnological Research - yzy@ocean.org.il

Abstract

The potential impact of backwash and brine discharge on the standing stocks and productivity of phytoplankton and bacterioplankton was monitored at the area of the outfall of a reverse-osmosis based desalination plant. Preliminary results indicate that the backwash, that includes iron hydroxide used as a coagulant, may have a potentially inhibitive impact on the microbial biota found near the outfall.
Keywords: Chlorophyll-a, Bacteria, Levantine Basin, Primary Production

Three surveys (April and August 2008 and April 2009) were conducted in the area of a brine outfall of the desalination plant in Ashkelon, Israel. The water quality aspect is described by Dromi et al (Submitted abstract, CIESM 2010) and the current presentation relates to the possible impacts of the brine outfall on phytoplankton and the bacterial community. Although one may assume that brine by itself is diluted rapidly and does not leave a detectable impact even of sessile organisms [1], the discharge of a coagulants and antiscalants (added for the amelioration of seawater prior use in the plant) poses potentially a stress factor for biota. Water samples were collected before, during and after the pulsed discharged of the backwash, along a gradient from the more affected area to apparently clear (non affected) water area. It should be emphasized that brines from the desalination plant and the cooling water from the power station located at the same site were discharged continuously and only the backwash discharged was pulsed. Phytoplankton standing stock was assessed by the measurement of chlorophyll *a* (Chl) concentration and primary productivity by ^{14}C-labeled bicarbonate uptake under standard conditions of 20 ºC and light flux of 100 mmol photon m^{-2} s^{-1}. Chl in the unaffected area was 1-2 mg m^{-3}, but as low as 0.15 mg m^{-3} following the discharge of the backwash. Most of the algal biomass was composed of cells larger than 10 micron in diameter, and microscopic qualitative examination revealed that diatoms and dinoflagellates dominated phytoplankton. Comparison of acidified and non-acidified Chl extracts showed phaeophytin (and Chl degradation products) constituted only a small fraction of chlorophyllous pigments, and thus we may assume that most phytoplankton cells collected from the sea samples were intact, indicating that physical damage was not part of water treatment impact. Chl-normalized photosynthetic activity ranged from 1.1 to 6.8 mg C mg Chl^{-1} $h^{-1}$and showed a trend of inverse relationship with the proportion of the coagulant in seawater (Fig. 1). The latter was assed by reddish hue imparted by the presence of iron hydroxide and determined by spectrophotometric examination of the sea water at 400 nm.

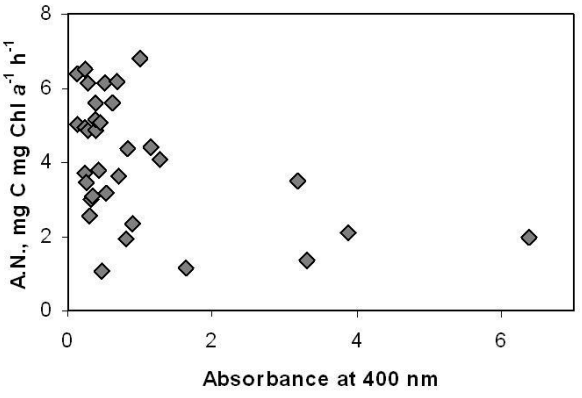


Fig. 1. Plot of assimilation number (A.N.), which is the expression of chlorophyll *a*-based value of primary productivity, against absorbance at 400 nm determined spectrophotometrically.

Bacterial counts were conducted in DAPI stained sub-samples. Bacterial density was also inversely correlated with the distance from the outfall and time elapsed since the backwash discharge, and varied from 1.8 and 41.1*10^8 cell L^{-1}. Cell number-normalized bacterial productivity, measured under standard conditions by ^{14}C- labeled leucine, increased from the outfall site towards clear water, approximately proportionally to the manner seen in the biomass-based phytoplankton productivity. Rates of algal and bacterial productivity were positively correlated, however the relationship between the rates changed between experiments (Fig. 2).

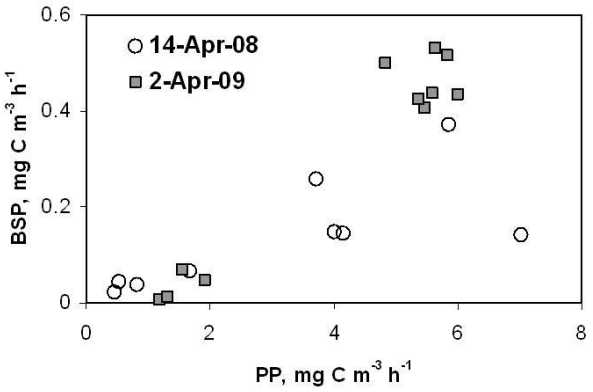


Fig. 2. Comparison of the rates of primary productivity (PP) and bacterial secondary productivity (BSP) offshore the desalination plant offshore Ashkelon, Israel.

While the spatial trend of increase of standing stocks of phytoplankton and bacteria towards the clear, unaffected water indicate, probably, just the dilution impact of the backwash discharge from the desalination plant, modification of rates is apparently a display of the inhibitive role of the saline concentrate and/or accompanying chemicals on microbial physiology. However, further investigation is required to elucidate: 1) what is the mode of action of the components of the backwash discharge, and 2) does the inhibitive action of the backwash water confers a risk of modification of the planktonic microbial community in the area of discharge on the long run.

References

1 - Raventos N., Macpherson E. and Garcia-Rubieis A., 2006. Effect of brine discharge from a desalination plant on macrobenthic communities in the NW Mediterranean. *Marine Environ. Res*., 62:1–14.

CHLOROPHYLL A VARIATION VERSUS HYDROLOGICAL CONDITIONS IN THE SOUTHERN MOROCCAN ATLANTIC COAST(BLANC CAPE AND BOJDOR CAPE)

Soukaina Zizah [1]*, Omar Ettahiri [1] and Mustapha Hasnaoui [2]
[1] Institut National de Recherche Halieutique - soukainazizah@yahoo.fr
[2] Faculté des Sciences et Techniques, BP 523, 23000Beni Mellal

Abstract
Three models were defined depending on the location of the maximum of chlorophyll'a' either in the axis coast/ offshore and in the water column (shallow or deep water). During 1998, in the 1st model two cells of great contents of chlorophyll 'a' were met, one in the coast and the other in the offshore.The 2nd model has an opposite evolution compared to the 1st model.In the 3rd model the chlorophyll 'a' maximum is recorded in the coast describing a decreasing gradient coast-offshore. In 1999, the maximum is at the offshore stations in the 1st model; 2nd model where the maximum occupies an intermediate or central situation. 3rd model two cells were presented: one at the coast, and the other in the offshore identified only at Dakhla region.
Keywords: Chlorophyll-a, Upwelling, Vertical Profile

Introduction
The vertical movements of the upwellings are interesting from physical and biological point of view, since they affect the quantities of nutrients brought into the euphotic zone and consequently the organic production of water. Thanks to the fertilizing contribution of deep water, the production and the productivity of phytoplankton rise. Moroccan Atlantic coast has the privilege to be among the 5 areas in the world influenced by this phenomenon which is also called resurgence of cold water.

Material and Methods
Data of this study comes from sea cruises onboard of the russian R/V Atlantniro (1998) and Atlantida (1999). The water samples intended for the proportioning of chlorophyll `a' are analyzed by the fluorimetry. The frequency of buoyancy called also frequency of Brunt Väisälä represents the intensity of the stratification of the water column, and thus its stability. The depth, where this frequency is the highest, it corresponds to the depth of the thermocline (1). And finally, we used the immersion at which 1% of surface radiation arrives, which delimits more or less the euphotic layer or the layer of photosynthesis. In order to comprehend the study, vertical distributions of chlorophyll 'a' detailed by transects were analyzed.

Results and Discussion
Primary production is important within Cape Blanc, a rich place in nutrients brought in one hand, by an upwelling which occurs year along, and on the other hand by SACW (2). Moreover, this zone corresponds to the richest zone in terms of chlorophyll `a' average (calculated within the euphotic layer). It reaches the order of 6 mg/m^3 in the area located at the north of this zone, (figure1), where a certain homogeneity of its water column is noticed, represented by low frequencies (not exceeding 0.02 units), except for Cape Bojdor (26°N) where a degree of stability going up to 0.06 units was met.

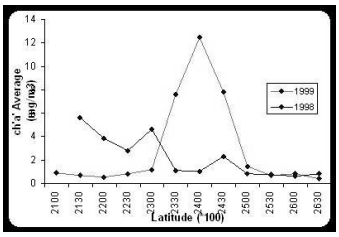


Fig. 1. Evolution of chlorophyll'a' average versus coastal stations latitudes (mg/m^3)

It is reminded that the character of homogeneity of the majority of the stations of the northern zone was noticed also on the vertical distributions of chlorophyll 'a' , and which coincides with rather low values in terms of average of chlorophyll `a'. In the second time and for more clarity reasons, we used the vertical distributions of the frequencies of Brunt Vaïsala along the main transect. Figure 2 shows that in Bojdor Cape, it is obvious that a thermocline on the surface is presented by the isoline of 0.06 units.

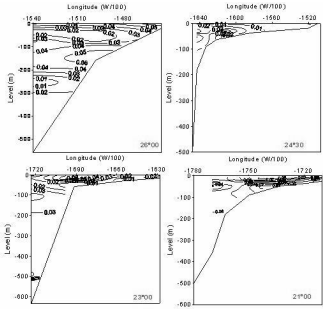


Fig. 2. Vertical Distribution of Brunt Vaisala Frequency during 1998

It would be due to an upwelling which has just started, and which would be identifiable by the character of homogeneity of its isolines, by the cold water patch raised at the coast, and likely by an apparent starting of phytoplankton development, schematized by chlorophyll'a' assimilation rate. This can be explained by two ways: (i) A recent upwelling character of Bojdor Cape. Indeed, following (3), in the stations where the upwelling is recent, nutrients are very abundant, but the phytoplankton development starts and water is hence relatively clear. (ii) This second point rises from the first, and which stipulates that high pulses of wind cause a ascendance of cold and nutrient rich water, and turns to be turbulent. The conditions are thus unfavourable, since thickness of the euphotic layer is reduced. Light, becomes a limiting factor and nutrients are not consumed (3). This explains perfectly the high percentages of phosphates of 0.9µgat/l in Cape Bojdor. On the other hand, in Cape Blanc, the frequency of buoyancy reaches its maximum, like it was announced previously. For the other transect, the vertical distributions of Brunt Vaisala frequencies show identical structures to those of chlorophyll `a' in the euphotic layer. In other terms, the two cells of big concentrations (coast and offshore) met in the area of Dakhla coincide with high values of frequency. In addition, the major maxima of chlorophyll correspond to the thermocline. Indeed, 44% of the stations show that the maximum of chlorophyll 'a' is less deep than the pycnocline. Whereas only 23% of the stations are located at the same depth as of the pycnocline and 32% are at a deeper levels.

References
1 - AGUSTI S., & C.M. DUARTE., 1999. Phytoplankton chlorophyll'a' distribution and water column stability in the Central Atlantic Ocean. *Oceanol. Acta* (1999) 22: 193-203.
2 - MINAS H. J., M. MINAS & B.COSTE., 1978. Rôle de l'oxygène dans le système production -regeneration des résurgences côtières Nord- Ouest Africaines. In Symp. Can. cur: Upwelling and Living Resources, Las Palmas. Number 69.
3 - MOREL A., 1982. Optical properties and radiant energy in the waters of the Guinea Dome and the Mauritanian upwelling area in relation to primary production. 183: 93.

CARBON FLOW MEDIATED BY MICROBIAL COMMUNITIES IN THE EASTERN MEDITERRANEAN SEA

A. Zoppini [1]*, S. Amalfitano [1], S. Fazi [1], S. Tugrul [2], Z. Uysal [2] and A. Puddu [1]
[1] IRSA-CNR (Italy) - zoppini@irsa.cnr.it
[2] IMS-METU (Turkey)

Abstract

Planktonic microbial communities play an important role in controlling the CO_2 flux between the atmosphere and the ocean. C-uptake (primary and bacterial production) have been analysed more extensively than mineralization processes (community respiration). This has given rise to a gap for a complete knowledge of C-flux in the marine environment. The research activity conducted in the frame of the EU Project SESAME (WP 3.8.2) provided new data on biological processes in the Cilician Basin. This area showed the heterotrophic nature of the off-shore site (P/R<1) with the potential to represent a consisting CO_2 source.

Keywords: Bacteria, Primary Production

The net flux of CO_2 between the atmosphere and the ocean is mostly controlled by the balance among three key processes mediated by the microbial communities: 1) uptake by phytoplankton photosynthesis (CO_2 uptake) 2) mineralization processes (CO_2 emission) 3) export toward the ocean depths. Phytoplankton is responsible for roughly half of the CO_2 fixation on the earth and at least 50% of the fixed C is channelled through the microbial food web in the dissolved phase [1]. In pelagic ecosystems heterotrophic bacteria mediate a significant conversion of dissolved organic carbon to biomass, which is then transferred to the food web. Only a small fraction of this organic matter is buried in marine sediments being the bulk of the produced organic matter remineralised trough respiration [2]. As a consequence oceans can act as net source or sink of carbon depending on the production or decomposition of organic matter due to biological activities. Recent comparative studies have suggested that respiration may systematically exceed production in large areas of the oceans [3]. The E Mediterranean Sea is considered one of the most oligotrophic regions in the world, in terms of both primary productivity and autotrophic biomass [4]. The Cilician Basin occupies the NE part of the Levantine Basin (Fig.1) and so far no data on primary production, bacterial production and community respiration rates are available.

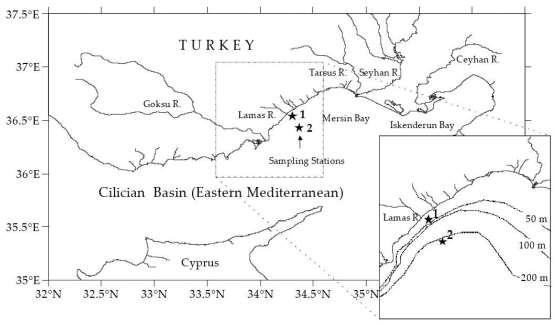


Fig. 1. Cilician Basin: location of samplig sites utilized in the EU project SESAME

To fill this gap, two short cruises (March 2008 and February 2009) have been carried out in the Cilician Basin, on board of R/V Bilim-2 of IMS-METU, and samples were taken from two sites representative of mid-shelf and offshore conditions. Depth profiles of the microbial community activities were analyzed in terms of primary production (PP, $NaH^{14}CO_3$ uptake), bacterial carbon production (BP, ^{3}H-leucine inc.) and community respiration (CR, changes in dissolved oxygen by Winkler method) along with bacterioplankton and phytoplankton cell abundances. Bacterial community composition was analyzed by CARD-FISH along with phytoplankton composition. The frequencies of cells with DNA de novo synthesis were determined by thymidine analog 5-bromo-2-deoxyuridine (BrdU). Chlorophyll a and nutrients were also analyzed along with organic matter concentration. Chemical parameters revealed the ultraoligotrophic conditions of these sites. Chlorophyll a reached the highest concentration (0.2 mg m^{-3}) in the mid-shelf station. In the off-shore site photosynthetic C-uptake accounted for 1.6-2.1 mmol C m^{-2} h^{-1} whereas bacterial C-uptake accounted for 0.03-0.08 mmol C m^{-2} h^{-1}. PP and BP rates measured in this survey were comparable with those reported for the near E Mediterranean areas [5-6] for the ultra-oligotrophic Cyprus Eddy and for the oligotrophic Cretan Sea, respectively. The C-release due to community respiration accounted for 3.5-17.3 mmol C m^{-2} h^{-1}. The mid shelf site differed for a higher C-uptake (PP 2.7-6.5 and BP 0.10-0.15 mmol C m^{-2} h^{-1}) and a lower C-release (CR 2.0-2.8 mmol C m^{-2} h^{-1}). The heterotrophic nature of the off-shore site is described by the PP/CR ratio <1. These preliminary results define this area as a potential CO_2 source.

References

1 - Ducklow H.W., Carlson C.A., 1992. Oceanic bacterial production, in "Advances in Microbial Ecology" (K.C. Marshall Ed.), Plenum Press, New York, Vol. 12: 113-181.

2 - Ducklow H.W., 1995. Ocean biogeochemical fluxes: New production and export of organic matter from the upper ocean. *Rev. Geophys. Suppl.*: 1271-1276.

3 - Duarte C.M., Agusti S., Aristegui J., Gonzales N., Anadon R., 2001. Evidence for a heterotrophic subtropical northeast Atlantic. *Limnol. Oceanogr*. 46(2): 425-428.

4 - Psarra S., Tselepides A., Ignatiades L., 2000. Primary productivity in the oligotrophic Cretan Sea: seasonal and interannual variability. *Prog. Oceanogr*. 46: 187-204.

5 - Psarra S., Zohary T., Krom M.D., Mantoura R.F.C., Polychronaki T., Stambler N., Tanaka T., Tselepides A., Thingstad T.F., 2005. Phytoplankton response to a Lagrangian phosphate addition in the Levantine Sea. *Deep-Sea Res*. II 52: 2944-2960.

6 - Van Wambeke F.V., Christaki U., Bianchi M., Psarra S., Tselepides A., 2000. Heterotrophic bacterial production in the Cretan Sea. *Prog. in Oceanogr*. 46: 205-216.

HYDROCARBON POLLUTION IN TUNISIA COASTS: EVALUATION AND BIOREMEDIATION

Ines Zrafi [1], Amina Bakhrouf [1], Abdelghani Sghir [2] and Dalila Mosbahi Saidane [1]*
[1] Laboratoire d'Analyse, Traitement et Valorisation des Polluants de l'Environnement et des Produits - Dalila.Saidane@fphm.rnu.tn
[2] CEA Genoscope, Evry, France

Abstract
We investigated the composition and spatial distribution of hydrocarbons found in Tunisian's marine environments. Although moderate, these hydrocarbon concentrations should ideally be reduced. Then, we investigated the characterization of bacterial diversity of polluted seawater. Molecular analysis of bacterial composition associated with hydrocarbon composition analysis provided evidence that microbial composition dynamics is related to changes in substrate composition, and there is a close relationship between the proliferation of specialized species and their function in the degradation of the different fractions of oil.
Keywords: Bacteria, Pollution, Coastal Management, Monitoring

Introduction
Sea Coastal were being the receptor of diverse pollutants. Sea water, [1], [2] marine sediment [3] and interstitial water [2] were the subject of this pollution. In the Mediterranean sea, pollution is related to the increase of industrialized and newly industrialized countries. The mediterranean coast in Northern Tunisia is one of such industrialized and populated region [4], [5]. On the other hand, hydrocarbons are one of the most important pollutants that can persist for years [6]. Microbial degradation is the major natural route for cleaning up oil spills [6]. Characterizing microbial diversity and identifying microorganisms which play a key role in the degradation of pollutants could be useful in defining new strategies for bioremediation. The aim of this work is to better understand the present status of environmental pollution by petroleum derives on tunisian coast and to analyze the bacterial diversity during oil degradation in order to contribute to the understanding of the bioremediation technology in a marine environment.

Materials and Methods
Hydrocarbon analysis: Hydrocarbons were extracted using chloroform. The extract (TH) was fractionated into non aromatic hydrocarbon (NAH) and aromatic hydrocarbons (AH) by adsorption liquid chromatography using a column of silica-gel. The TH, NAH and AH were determinate and were analyzed with a gas chromatograph.
Molecular analysis: Direct extraction of total microbial DNA from polluted seawater samples, amplification of 16S rRNA genes, cloning, sequencing, chimera check and phylogenetic rRNA gene sequence analysis were performed. All sequences were imported in the ARB database and compared to the GenBank database using BLAST. They were aligned using the ARB program and then manually checked. A distance matrix was generated and used by the DOTUR computer program to define Operational Taxonomic Units (OTUs). A 97% sequence similarity cut-off was used to define an OTU).
Bioremedation essays : Biodegradation assays were carried out in seawater inoculated directly with fresh culture of an adapted microflora. The efficiency of biodegradation corresponding to each incubation period was calculated for the various fractions of TPH, NAH or AH at various incubation periods.

Results and discussion
1. Evaluation of hydrocarbon pollution
TH concentrations differed from one site to another. NAH and AH levels showed a variation among the collection sites, with an average of 66.22–211.82 µg/g for NAH and 13.84–115.60 µg/g for AH. NAH was predominant. GC traces show unimodal distribution of n-alkanes, equivalent distribution pattern of both odd carbon-numbered alkanes and even-carbon-numbered alkanes. All geochemical markers enable us to make the hypothesis of petroleum source contribution. Our results show that the TPH levels were relatively low compared to those of locations around the world reported to be chronically contaminated by oil.

2. Bacterial diversity of polluted seawater
AM microflora represent the natural bacterial population of seawater from a region adjacent to an oil refinery. A total of 94 clone sequences were obtained for the AM clone library. They show a percentage of sequence identity to the closest related sequences in the public databases ranging between 91% and 100%. The 16S rRNA gene sequences can be grouped into 22 OTUs, of which 16 OTUs are affiliated with cultivated microorganisms while a unique OTU is affiliated with a noncultivated microorganism with $\geqslant$97% sequence identity. A total of 5 OTUs represent novel OTUs sharing less than 97% sequence identity. Detailed analyses of the AM clone library indicated that the abundant phylotypes are distributed within the Alpha-, Beta-, and Gammaproteobacteria subclasses. The minor phylotypes are distributed within the Actinobacteria, the Firmicutes, and the Bacteroidetes groups. The existence of bacteria in petroleum-contaminated sites suggests that many species have evolved specifically in these environments and may be active in the metabolism of hydrocarbon.

3. Bioremediation efficiency of the adapted microflora
The amount of TPH and AH decreased after 3 days. NAH and AH biodegradation reached the highest value (92.6%; 68.7%) at the end of the incubation period. A slight decrease in NAH degradation was detected at day 21. Detailed chromatogram analysis showed visible degradation of n-alkanes ranging from n-C14 to n-C24 during the first week. Branched alkanes were degraded during W2. At the end of W3, the majority of n-alkanes were totally degraded. Community composition changes began during the first week (W1) and remained significant during the whole incubation period. At S3 and S4, we observed a major decrease in bacterial diversity, confirmed by diversity indexes. Bacterial diversity is gradually reduced during the biodegradation process. We found that in W1, W2 and W3. The 16S rRNA sequences are affiliated with the same microorganisms detected in the AM library, with variation in their proportions and the emergence of new species. We concluded that the AM consortium shows a high performance of degradation of both NAH and AH components.

Conclusion
Our findings indicate hydrocarbon contamination in region of study. The use of bacterial diversity analysis could be useful in defining new strategies for bioremediation. Finally, to further elucidate the role of these bacterial groups in hydrocarbon degradation, catabolic gene expression profiling may be necessary.

References
1 - Jaffrennou,C., Stephan L., Giamarchi P., Cabon J.Y., Burel-Deschamps L. and Bautin, F., 2007. Direct fluorescence monitoring of coal organic matter released in seawater. *Journal of Fluorescence*, 17: 564-572.
2 - Pérez-Carrera E., León V.M., Parra, A.G. and González-Mazo E., 2007. Simultaneous determination of pesticides, polycyclic aromatic hydrocarbons and polychlorinated biphenyls in seawater and interstitial marine water samples, using stir bar sorptive extraction-thermal desorption-gas chromatography-mass spectrometry. *Journal of Chromatography*. A, 2: 1170 (1-2), 82-90.
3 - Wakeham S.G., 1996. Aliphatic and polycyclic aromatic hydrocarbon in Black Sea sediments. *Marine Chemestry* 53: 187-205.
4 - Zrafi-Nouira I., Khedir-Ghenim Z., Zrafi F., Bahri R., Cheraeif I., Rouabhia M. and Saidane-Mosbahi D., 2008. Hydrocarbon Pollution in the Sediment from the Jarzouna-Bizerte Coastal Area of Tunisia (Mediterranean Sea). *Bull. Environ. Contam. Toxicol.* 80(6):566-572.
5 - Burns, K.A., and Teal J.M., 1979. The West Falmouth Oil Spill: Hydrocarbons in the salt marsh ecosystem. *Estuarine and Costal Marine Science*, 8: 349–360.
6 - Kasai Y, Kishira H, Syutsubo K, Harayama S., 2001. Molecular detection of marine bacterial populations on beaches contaminated by the Nakhodka tanker oil-spill accident. *Environ Microbiol.* 3(4):246-55.

OBSERVATIONS ON THE ABUNDANCE OF HOLOTHURIAN SPECIES ALONG THE ALEXANDRIA COAST, EGYPT

F. A. Abdel Razek [1]*, M. H. Mona [2], S. H. Abdel Rahman [1], M. M. El Gamal [2], R. M. Moussa [1] and S. M. Taha [1]
[1] National Institute of Oceanography & Fish (NIOF), Egypt - Fatma_abdelrazek@hotmail.com
[2] Zoology Department, Faculty of Science, Tanta University

Abstract
Sea cucumber plays an important role in marine communities besides it's great economical importance to man. By 2000, production increased from 20 tones in 2000 to 2310 tones in 2002, and then dramatically decreased to 6 tons in 2006 [1]. The present study presents abundance, distribution size composition of Holothurians along Alexandria coast of Egypt. Samples were anaesthetized in $MgCl_2$ (2.5%) solution to overcome the error resulted from contraction and relaxation of body muscles[4].
Keywords: Eastern Mediterranean, Biodiversity

Introduction and Methods
Two species of holothurians *Holothuria arenicola* and *Bohadshia* orgus were recorded. The abundance was 98% and 2% for *H. arenicola* and *B.argus*, respectively. 2015 Samples were collected randomly using quadrate transect (20 m × 10 m) from the selected sites along the Alexandria coast in eastern Mediterranean Sea during the period from January 2005 to July 2007 as in fig. 1. The distribution and abundance of Holothurian species were calculated by counting the number of each species per 200 m^2. Samples were anaesthetized in magnesium chloride (2-5%) solution to over-come the error resulted from contraction and relaxation of body muscles [4]. Samples weighed with a digital balance, then gently straightened and their lengths measured to 1 mm with a ruler. The total length (TL), total wet weight (Twt) was measured for each specimen.

Results and discussion
During the present study only two species of holothurians; *Holothuria arenicola* and *Bohadshia argus* were recorded. *H. arenicola* was the most abundant species along the Alexandria Coast of Egypt. The abundance percentage was 98% and 2% for *H. arenicola* and *B. argus*, respectively.

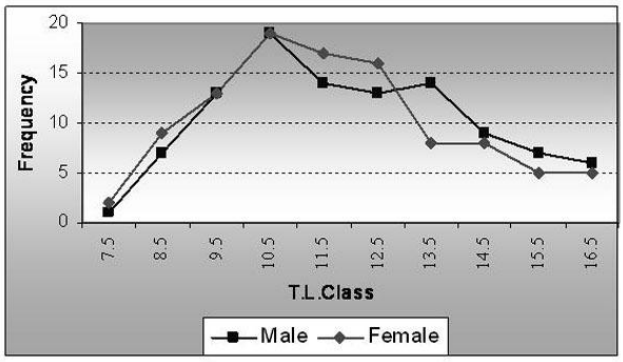


Fig. 1. Length Frequency distribution of male and female *Holothuria arenicola*

Length distribution of *H. arenicola* for males and females as presented in fig. (1). Regardless of male and female, the most frequent length was in range of 9.5 to 13.5 cm. By comparing the present results with that [3] decrease in frequent length in clearly observed as 11.0 – 15.7 in 1999 to 9.5 – 13.5 cm in 2007. This reflects the intensive fishing activity in the last years which supports the necessity of rapid management of *H. arenicola* fishery in Mediterranean Sea. It is found that smaller individuals observed in winter and autumn which may be attributed to the fact that the fishing activity in summer and spring is higher as well as the fishing selection during these seasons is lead to presence of small sized animals in autumn and winter. Further migration and hence greater habitat separation between juveniles and adults of some species may occur as holothurians mature [2]. The regression equations of length-weight relationship for male and female of *H. arenicola* were described in (Table 1). In the present study, regardless of sex and season, the slope was ranged between 0.8 – 1.3 that was significantly different from 3. This means that length does not grow at the same rate of the weight. [3] reported negative allometric relationship for *H. arenicola.* The higher regression coefficient in the present study reflectes the fitted length weight relationship. The present information confirmed that *H. arenicola* along the Alexandria coast of Mediterranean Sea is exposed to over fishing during the last eight years as a result of drastic increase in demand for sea cucumber as bech-de-mer. The problem of over fishing can be overcome through firm and conservative management as well as aquaculture of this valuable resources.

Tab. 1. Regression equation of weight relationship of male and female *Holothuria arenicola*

Sex	Regression Equation	R^2	n
Male	$W=7.4107\ L^{0.8473}$	0.9484	103
Female	$W=47.9351\ L^{0.8372}$	0.8572	102

References
1 - Ahmed, M. I. (2006): Taxonomic and fishery stock status of sea cucumber in the Egyptian Red Sea. M. Phil. Thesis. Hull University.
2 - Hamel, J. F., and Mercier, A. (1996b): Studies on the reproductive biology of the Atlantic sea cucumber *Cucumaria frondosa*. SPC Beche-de-mer Info. Bull. 8:22-33.
3 - Raouf, W. K.; Fatma, A. A., and Mohamed, H. Y. (2000): Population growth and asexual reproduction of the sea cucumber *Holothuria arenicola* from the eastern Mediterranean. Egypt. J. Aquat. Bull.&Fish., Vol.4, No.4 :119-135.
4 - Sewell, M. A. (1992): Reproduction of the temperate aspidochirote *Stichopus mollis* (Echinodermata: Holothuroidea) in New Zeland. Ophelia, 35:103-121.

MEAN TROPHIC LEVEL ESTIMATION OF THE CATCH OF VARIOUS FISHING GEARS (N. AEGEAN)

Aggeliki Adamidou [1]* and Argyris Kallianiotis [1]
[1] Fisheries Research Institute, NAGREF, N. Peramos, 64007 Kavala (Greece) - adamidou@inale.gr

Abstract
The mean trophic level (mTL) for the fish catch of bottom trawlers, purse seiners and trammel nets that operate in the northern Aegean Sea was estimated and compared aiming to examine the possible impact of various gears on the marine ecosystem. The mTL of the catch was 3.89 (±0.021 S.E) for the bottom trawls, 3.69 (±0.035 S.E) for the trammel nets, and 3.33 (±0.029 S.E) for the purse seines.
Keywords: Aegean Sea, Fisheries, Food Webs

Introduction
Trophic level (TL) is an ecological indicator widely accepted and used for quantification of the ecosystem effects of fishing and for the management of fisheries resources [1]. Fishing in the Thracian sea is carried out by bottom trawls, purse seines and small-scale fishing gears. The mean trophic level (mTL) of their catches can be used to quantify whether a fishing gear removes high or low trophic level organisms from the ecosystem and the extent each gear contributes to the fishing down of the marine food webs [1]. The aim of the present study was to estimate the mTL of the catches of the three most commonly used fishing gear (purse-seines, bottom trawls and trammel nets) in the northern Aegean Sea.

Materials and Methods
Data were collected by on board sampling during 2004 in the Thracian Sea (northern Aegean Sea). Thirty-six seasonal trials were performed by each gear with commercial vessels. Regarding trammel nets, 9 different mesh sizes were used (36, 42, 60, 64, 72, 76, 80, 84, 90 mm full mesh of inner panel). The mTL of the fish catches was estimated by gear, and weighted by the weight of each species participated in the catch. The mTL of the three gears was compared with ANOVA and the Fisher's LSD test was used to determine which means were significantly different from which others. The values of TL used were obtained from literature [2], [3].

Results and discussion.
The estimated mTL of the total catch was 3.89 (±0.021 S.E) for bottom trawls, 3.33 (±0.029 S.E) for purse seines, and 3.69 (±0.035 S.E) for trammel nets (Fig. 1). The comparison of the mTL per gear indicated that there was a statistically significant difference between the means of the 3 gears (ANOVA, F-Ratio:108.75, p<0.0000). The mTL of trammel nets ranged according to target species from 3.3 (for Mullus sp) to 3.9 (for large speciments of Sparidae). The above gears operate in different way and exploit different stocks or different parts of the same stock. Bottom trawls, fish a great variety of demersal and benthic mainly piscivorous species therefore, the mTL of their catches was the highest among the gears. Purse seines fish in the pelagic domain and catch pelagic, planktivorous species of small and medium size thus, the mTL of their catches was lower. Trammel nets exploit certain sizes and species of demersal and benthic fish. The mTL of their catches increased with the mesh size as a consequence of the positive relation between TL and body length [4]. Conclusively, it could be said that bottom trawls contribute more than the other two gears to "fishing down the marine food web". However, the removal of vast quantities of lower TL species, as it happens with purse seines catches, might lead to bottom up cascading effects that also affect negative the marine ecosystem.

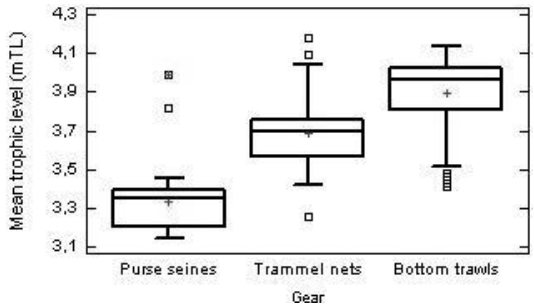


Fig. 1. Box-whisker plots of mean trophic level (mTL) per gear

References
1 - Pauly D., Christensen V., Dalsgaard J., Froese R. and Torres F., 1998a. Fishing down marine food webs. *Science* 279: 860–863.
2 - Stergiou K.I. and Karpouzi V.S., 2002.Feeding habits and trophic levels of Mediterranean fish. *Rev. Fish Biol. Fish.*, 11: 217-254.
3 - Karachle P.K. and Stergiou K.I., 2006. Trophic levels of North Aegean Sea fishes and comparisons with those from FishBase. *In*: Palomares M.L.D., Stergiou K.I. and Pauly D. (ed.), Fishes in Databases and Ecosystems. Fisheries Centre Research Reports 14(4), pp. 22-26.
4 - Stergiou KI. And Karpouzi V.S.. 2005. The trophic position of fishes in Hellenic marine ecosystems. *In*: Papathanassiou E. and Zenetos A. (ed) State of the Hellenic marine environment. HCMR, Athens, pp 280-284.

POPULATION STUDY OF THE FAN MUSSEL *PINNA NOBILIS* L., IN TWO AREAS OF SARDINIA (W-MEDITERRANEAN)

Piero Addis [1]*, Marco Secci [1], Stefano Corrias [1] and Andrea Manunza [1]
[1] University of Cagliari - Dep. Animal Biology and Ecology - addisp@unica.it

Abstract
We investigate the population ecology and conservation status of the endangered Mediterranean bivalve *Pinna nobilis*. Spatial distribution, size structure, shell orientation and valve colonization by epibionts were the main descriptors investigated in two areas of Sardinia: S. Antioco island and the Gulf of Oristano (Sardinia, western Mediterranean).
Keywords: Bivalves, Endemism, Conservation, Tyrrhenian Se

Introduction
The fan mussel, *Pinna nobilis* L., is an endemic Mediterranean species considered to be endangered, whose preservation is urged mainly through the Barcelona Convention and the Habitats Directive. There has been a knowledge-gap in the ecological status of the populations and also in the response to the enforcement of conservation measures, particularly in the insular areas as well as the north African countries [1]. The fan mussel has historically been harvested for different purposes: human consumption, shell collection and for the production of "sea silk" from byssus. In Sardinia (W Mediterranean) were known four main critical areas characterized by large fan mussel beds: the Gulf of Alghero (NW coast), the Gulf of Olbia (NE coast), S. Antioco island (SW coast) and the Gulf of Oristano (W coast). In order to assess the conservation status of this species an investigation started in 2008. Here we present the main results from two areas studied.

Material and Methods
Underwater visual counts of specimens (live and dead), size measurements (total height in cm), shell orientation (0-360°) and epibiosis of valves (by digital pictures), were collected within a detailed sampling design. Data collected refers to 50 quadrats (10x10 m) randomly replicated and geo-referenced. Density was expressed as the number of specimens/100 m^2. Valve orientation was analyzed by the Rayleigh test, while epibiontic data were analyzed using one-way Analysis of Similarities (ANOSIM) based on differences in the spatial scales.

Results
A total of 530 and 725 specimens of P. nobilis were counted and measured respectively in Gulf of Oristano and S. Antioco island. Specimen densities showed significant differences between the two areas analysed. Density of live + dead specimen varying from 4.42 (± 3.09 SD) to 20.33 (± 6.76 SD) specimens/100 m^2 in Gulf of Oristano; from 1.75 (± 1.22 SD) to 48.67 (± 21.42 SD) specimens/100 m^2 in S. Antioco island. Specifically we found that spatial distribution and shell orientation of specimens depends on local ecological features (Fig. 1-2).

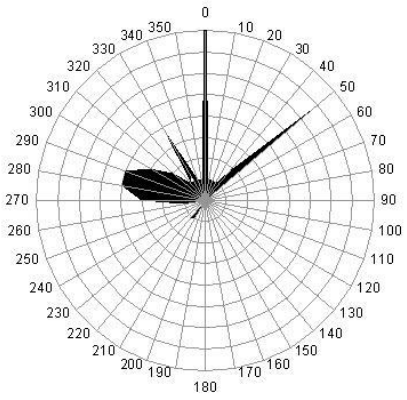


Fig. 1. Rose diagram reporting shell orientation in the the Gulf of Oristano

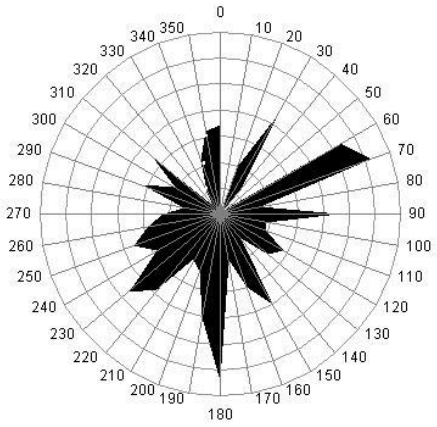


Fig. 2. Rose diagram reporting shell orientation in S. Antioco island

Discussion
The high density values found in both areas to indicate the good health conditions of these populations; moreover values found are much higher than those estimated in other Mediterranean areas [2,3]. *P. nobilis* populations are particularly vulnerable to anthropogenic impacts such as structural changes of seagrass meadows, mechanical impacts due to dredging, anchoring, trawling and entanglement nets and we argue the fact that the protection of populations should match with the protection of the habitat.

References
1 - Addis P., Secci M., Brundu G., Manunza A., Corrias S. and Cau A., 2009. Density, size structure, shell orientation and epibiontic colonization of the fan mussel *Pinna nobilis* L. 1758 (Mollusca: Bivalvia) in three contrasting habitats in an estuarine area of Sardinia (W Mediterranean). *Sci. Mar.*, 73(1): 143-152.
2 - García-March J.R., Garcìa-Carrascosa A.M., Pena Cantero A.L. and Wang Y.G., 2007a. Population structure, mortality and growth of *Pinna nobilis* Linnaeus, 1758 (Mollusca, Bivalvia) at different depths in Moraira bay (Alicante, Western Mediterranean). *Mar. Biol.*, 150: 861-871.
3 - Zavodnik D., Hrs-Brenko M. and Legac M., 1991. Synopsis on the fan shell *Pinna nobilis* L. in the eastern Adriatic sea. In: C.F. Boudouresque, M. Avon, V. Gravez (eds.), Les Espèces Marines à Protéger en Méditerranée, pp. 169-178. Gis Posidonie Publ., Marseille.

TEMPORAL VARIATION OF HYDROCHEMICAL PARAMETERS IN THE TRABZONCOAST (SOUTHEASTERN BLACKSEA) DURING THE SPRING OF 2009

Ertugrul Agirbas [1]*, Ali Muzaffer Feyzioglu [2] and Ulgen Kopuz [1]
[1] Karadeniz Technical University Faculty of Marine Sci. 61530 Çamburnu Trabzon TURKEY
[2] Rize University, Faculty of Fisheries,53100 Rize/TURKEY - eagirbas@gmail.com

Abstract
The study was conducted between March and May 2009 at one station in the Trabzon Coast (Southeastern Black Sea). Physical parameters were obtained by Idronaut Ocean Seven 316 CTD probe. Nutrients were measured by spectrophotometric methods (Parsons et al.1984). Chl-a analysis were carried out by HPLC technique. During the sampling period, Oxygen minimum layer was observed between at 160-170 meter depth. The seasonal thermocline was observed above 55 m in May 2009. PAR depths were observed min at 22 m and the max at 30 m in May and March respectively. Among the sampling period, the minimum nitrite, ammonium and silicate concentrations were observed in May 2009. Because of no nutrient limitation, among the environmental parameter studied, the light intensity is more important for phytoplankton spring bloom at the coastal area.
Keywords: Black Sea, Nutrients

Introduction
The Black Sea is a unique marine environment representing the largest landlocked/semi-enclosed and deep anoxic basin in the world. The coastal waters of the Black Sea are principally fed by the river input and by the lateral/ vertical nutrient transport mechanisms (1). In the spring period; the coastal area is characterized by homogeneity of the water column in respect of temperature, salinity and nutrients. Dissolved Oxygen (DO) gradually decreases with depth. The coastal marine eutrophication is significant which is characterized by higher nutrient content with compare to the surface water of the offshore areas. The aim of this study was to evaluate hydrochemical parameters of region, reveal hydrographic status and response of the phytoplankton biomass to environmental factors during the spring 2009, mixing period.

Material and Methods
The sampling was performed between in March-May 2009 at one station in the Trabzon Coast (Southeastern Black Sea). Water samples were taken from the surface to 60 m, 5 meter interval using 5 liter Niskin bottles mounted on a SEB 32 Carousel Rosette sampler. Hydrographic data were collected by using Idronaut Ocean Seven 316 CTD probe. Nutrients (nitrite, nitrate, ammonia and silicate) were measured by Shimadzu UV 1800 spectrophotometer (2). PAR was measured by Li-193 SA Spherical Quantum Sensor and Li-190 SAT Quantum terrestrial sensor. Chl-a analysis were carried out by using Shimadzu LC-20 AT/ Prominence HPLC (3).

Result and Discussion
The vertical distribution of temperature, salinity, dissolved oxygen and pH profiles were given in figure 1.

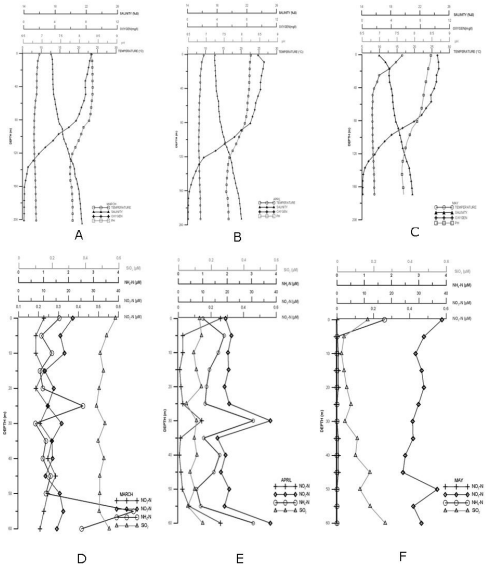


Fig. 1. CTD profiles (A: March, B: April, C: May) and Nutrient profiles (D: March, E: April, F: May)

DO was obtained as 9,96 mgL^{-1}, 10,72 mgL^{-1} 10,62 mgL^{-1} in March, April and May respectively at the surface water of sampling station. During the sampling period,Oxygen minimum layer was observed between at 160-170 meter depths. pH showed similar profile for March, April and May during the sampling period. Although the stagnation was present in March and the April 2009, the seasonal thermocline was observed above 55 m in May 2009. PAR depths were observed min at 22 m and the max at 30 m in May and March respectively (figure 2). Throughout spring 2009, the maximum concentrations of nitrate, nitrite, ammonium and silicate were not higher than 0,29 µM, 38,48µM, 3,06µM and 0,58 µM respectively in the whole sampling depth. Among the sampling period, the minimum nitrite, ammonium and silicate concentrations were observed in May 2009. Although the chlorophyll-a, which can be used as indicator of phytoplankton biomass, was to be expected to have high values at surface water in May , the maximum value was found as a 6,41µgL^{-1} at 15 m in March 2009 (figure 2).

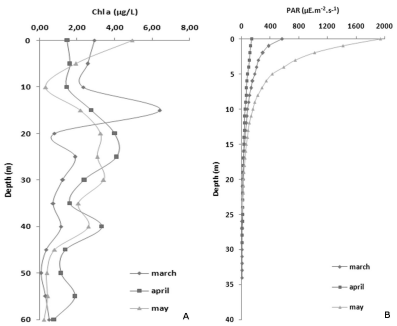


Fig. 2. Chl-a concentrations (A) and PAR values (B)

Because of no nutrient limitation, among the environmental parameter studied, the light intensity is more important for phytoplankton spring bloom at the coastal area. When not only the nutrient but also the chlorophyll-a concentrations were considered, it seem that the coastal water of Trabzon was eutrophic in spring 2009.

References
1 - Yilmaz A., Coban-Yildiz and Tugrul S., 2006. Biochemical cycling and multilayer production in the Black Sea, Geophysical Research Abstracts, Vol.8, 00541.
2 - Parsons T. R., Maita Y. and Lalli C. M., 1984. A manual of Chemical and Biological Methods for Seawater Analysis. 173.
3 - Jeffrey, S.W., Mantoura, R.F.C., Wright, S.W. (Eds.)., 1997. Phytoplankton Pigments in Oceanography. Monographs in Oceanographic Methodology. UNESCO Publishing, Paris

PARTITIONING OF THE NORTHERN TUNISIAN COASTS INTO HOTSPOTS OF CETACEAN DISTRIBUTIONS

Mehdi Aïssi [1]* and Mohamed néjib Daly yahia [1]
[1] Faculty of Sciences of Bizerte - mehdi.bfsa@yahoo.fr

Abstract

For two years 2008 and 2009, indications about cetacean sightings' aggregations were supplied by fishing boats. Based on weekly questionnaires to fishermen the most frequently encountered species were the bottlenose dolphins *Tursiops truncatus* representing 77.8% of all sightings and the common dolphin *Delphinus delphis* (22.2 %). Sightings positions were distributed over a grid of 5' longitude and 5' latitude to localize the "hotspots".

Keywords: Cetacea, Distribution Coefficient, Mapping

Introduction

Despite of the occurrence in Tunisian waters of all cetacean species known to be regular in the Mediterranean basin except Cuvier's beaked whales [1], [2], [3], [4], the information about their distribution is very scarce due to a lack of continuous studies [5]. This work was carried out by gathering data collected over two years 2008 and 2009 to reveal preliminary indications of cetacean distribution areas in northern Tunisian coasts.

Material and Methods

We estimated the aggregation of cetacean observations in some selective fisheries area from reports received from fisheries boats (2008 and 2009). This area encompasses the coastal and offshore waters of the northern Tunisian coast extending from the coastline to 38° N and from 009° E to 010° 30' E. Data were collected by means of questionnaires including specific questions about fishing area and cetacean sightings. 20 fishing boats were considered in this study according to two main variables: educational profile of fishermen and experience level in identifying cetacean species. Sighting is defined in this study as a visual detection of a group of cetaceans recorded at least by two different fishing boats. Sightings were distributed on the grid of the studied area with a cell size of 5' ^{x} 5', reaching 190 cells. Hotspots are cells where the species occurred more than three times during the same season.

Results and Discussion

For instance, 54 cetacean sightings were admitted and more than 20 were excluded due to incertitude. All observers reported sightings of small cetaceans principally bottlenose dolphins reaching the 77.8% and occasionally the common dolphins (22.2%). From the total of cells where fishing boats set sail, we identified 17 hotspots. Common dolphin sightings occupied only 4 hotspots confined to deep water in the northeastern part of the study zone, however bottlenose dolphin occupied 13 hotspots in coastal and offshore areas (Figure 1). Coastal cells were classified as a school ground for juvenile bottlenose dolphin to learn hunting techniques during autumn season [4].

This study highlights the ecological importance of particular zones off the northern Tunisian coasts that should be monitored.

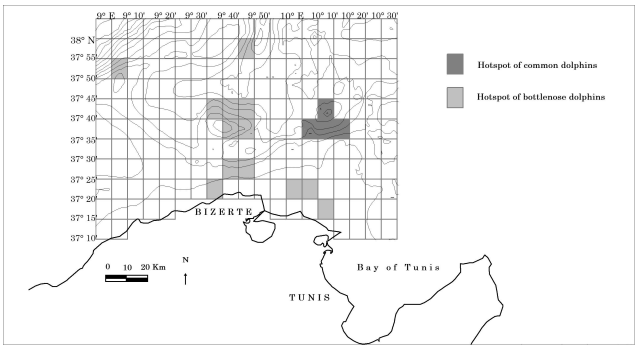


Fig. 1. Distribution of hotspots for common dolphins (in dark grey) and bottlenose dolphins (in light grey) in the northern Tunisian coasts estimated from fisheries boats during 2008 and 2009, with isobaths each 100 m

References

1 - Ktari-Chakroun F., 1980. Les cétacés des côtes Tunisiennes. *Bull. Inst. Natn. Scien. Tech. Mer de Salammbô.*, 7 : 119-121.

2 - Bradai M.N. and Ghorbel M., 1998. Les cétacés dans la région du golfe de Gabès. Premières mentions de deux Balaenopteridae : *Megaptera noveangliae* et *Balœnoptera acutorostrata*. *Bull. Inst. Natn. Scien. Tech. Mer de Salammbô*., 4 : 9-11.

3 - Ben Naceur L., Drouot V., Bourreau S., Gannier A., Bradai M.N., Laran S., Khalfallah N. and Makhloufi M., 2004. Recensement du grand dauphin *Tursiops truncatus* dans les eaux tunisiennes. *Bull. Inst. Natn. Scien. Tech. Mer de Salammbô*., 31 :75-81.

4 - Aïssi M. and Daly Yahia M.N., 2009. Is the bay of Bizerte a school ground for juvenile bottlenose dolphins (*Tursiops truncatus*) to learn hunting techniques? *In Proceed. of the first biennal conference on cetacean conservation in south Mediterranean countries*, 12-14 October 2009, Tabaraka, Tunis. (Abstract book p27)

5 - Notabartolo di Sciara G. and Bradai M.N., 2007. National action plan for the conservation of cetaceans in Tunisia. *In report of the third meeting of the contracting parties*, Dubrovnik, Croatia, 22 – 25 October, 2007, Accobams, MPO3-2007-Inf25.

MORPHOLOGICAL AND ECOLOGICAL CHARACTERISTICS OF MALVUFUNDUS REGULUS FORSKALL, 1775 FOUND IN ANTALYA BAY, TURKEY

Deniz Aksit [1]*, Beria Falakali mutaf [1] and Emine sükran Okudan [1]
[1] Akdeniz University Faculty of Aquatic Sciences and Fisheries - denizaksit@akdeniz.edu.tr

Abstract
Malvufundus regulus, an alien species in the Mediterranean Sea has been examined morphologically and ecologically in connection with submarine caves in Antalya Bay.
Keywords: Western Mediterranean, Mollusca, Bivalves

Introduction
Levantine Sea where the fauna has always been shown to get influenced by the lessepsian migration through the Suez Canal [1,2,3]. The Bay of Antalya is always exposed to that migration pressure. Many bivalve species belonging to the Indo-Pacific fauna were already recorded in Turkish waters. A member of Malleidae, *Malvufundus regulus* Forskall, 1775 is one of those remarkable lessepsian species, has been already extended to the Greek waters [2,5]. This work is to be informative about this alien species for better understanding its adaptation to a new ecosystem.

Material and Methods
Specimens were collected near the cave entrances at the depths of 1-5m by Scuba diving along the rocky cliffs of the Antalya Bay at $36^0$53′02″N–$30^0$40′ 47″E and $36^0$53′ 05″N–$30^0$41′54″E. Samples of *Malvufundus regulus* were taken to the laboratory for further investigation.

Results
Members of *Malvufundus regulus* were found as attached on rocks among other cemented bivalves such as *Spondylus spinosus*, and *Pinctada radiata* while a measurement of faunal abundance of the caves in the littoral zone of Antalya Bay. Solitary *M. regulus* seemed to prefer shaded rocks or their crevices but not on bare substrates and was observed in close association with the vegetal cover of the rocks (Fig.1).



Fig. 1. *Malvufundus regulus*

The rocky littoral zone of Antalya is found mostly covered by coralligen formations, constituted by several species of rodophyta, heterokontophyta and chlorophyta in numbers of 23, 9 and 8, respectively. Living forms of *M. regulus* were in upright position and adhere themselves to hard surfaces by a small but strong bundle of byssus threads. Shell has thin, translucent valves generally elongated posteroventrally, and shows a striking contrast in its shell form. Right valve is moderately convex, while the left is nearly flat or a little concave. A posterior tooth extends along the posterior part of the dorsal margin. The shell thickness differed that the dissoconch part was much harder and softened towards the posterior end gradually. Colour is found variable, some were dark purplish throughout, but yellow is also frequent. A pattern was seen to give a butterfly wing appearance at the posterior margin (Fig. 2a). The nacreous layer is very thin and restricted to the dissoconch. Valves held shut by one large adductor muscle. The body is laterally compressed. Soft tissues were mainly the mantle **(M)**, adductor muscle **(A)**, body **(B)** and the ctenidia **(C)**. The foot **(F)** appeared a very degenerative. Body organization could not be determined as it was almost flattened in shape. Byssus is produced from the center just above the ctenidia and extended out by the hinge. The gills were the most prominent structure **(Fig.2b)**.

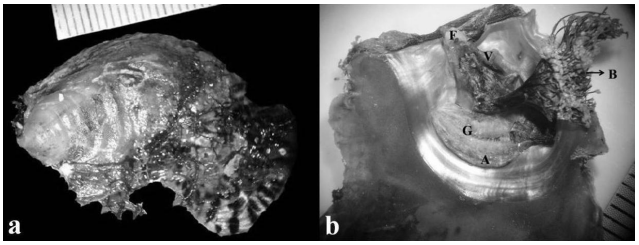


Fig. 2. A-b

Discussion
Submarine caves are semi-closed systems within the marine ecosystem [6] . Many marine invertebrate groups use cryptic habitats for settlement. *Malvufundus regulus* is such one that was frequent in the study area. The species is also described to inhabit in deeper waters [4].*M. regulus* is found singly. It is not a burrowing species as burrowers are usually lost their byssal aparatus [7]. The organism seemed to burrow slightly at its post-larval stage and then a permanent attachment is provided by byssus. The soft parts were confined in a much smaller and narrower chamber. But after settlement, the shell stated to grow only posteroventrally to an elongated valve which is to facilitate the posterior end in free communication with the water above [7]. The shell strength of the specimens differed along the shell as thickness is gradually reduced, is reckoned that shellstrength is directly correlated withshell thickness.The opportunity to examine the ecological and morphological status of such alien species helps for better comprehension of their connection between ecosystem and biodiversity changes in the Levantine Sea. The species become a strong competitor for space and food to persist under the fixed condition in the settling site. Surrounding vegetation seems an important biological factor as well as the physicals of light and wave exposure. It is assumed that a hydrodynamism is generated as a consequence of seaweed plasticity which helps to determine the sustainability of this alien species. Due to water currents the food particles become available for this filter feeding organism. Oxygen profile of the water is backed up by the existing seaweeds because oxygen consumption is closely related to production. Further studies will be needed focusing particularly the population dynamics of this organism relative to seasonal biological and physical conditions within the area.

References
1 - Zenetos A., Cinar M.E., Pannuci-P. M.A., Harmelin J.G., Furnari G., Andolara F., Bellou N., Streftaris N., Zibrowius H., 2005. Annotated list of marine alien species in the Medit. with records of the worst invasive species. *Med. Mar. Sci.* 6, 63-118.
2 - Zenetos A., Vardala-Theodorou E., Alexandrakis C., 2005. Update of the marine Bivalvia Mollusca checklist in Greek waters. *J. of the Marine Biol. Assoc. of the UK.* 85, 993-998.
3 - Cinar M.E., Bilecenoglu M., Ozturk B., Katagan T., Aysel V., 2005. Alien species on the coast of Turkey. *Mediterranean Marine Science* 6, 119-146.
4 - Ozgur E. and Ozturk B., 2007. Abundance of zoobenthic exotic species on rocky reefs in the southern Aegean Sea. 38th CIESM Congress Proc. *Rapp.Comm. int. Mer Medit.* 38, 565.
5 - Zenetos A., Koutsoubas D., Vardala-Theodorou E., 2005c. Origin and vectors of introduction of exotic molluscs in greek waters. *Belg. J. Zool.* 135, 279-286.
6 - Fichez, R. 1991., Suspended particulate organic matter in a Mediterranean submarine cave. *Marine Biology* vol. 108:p. 167–174.
7 - Gosling E. 2003., Bivalve Molluscs. Biology, Ecology and Culture. Fishing New Books, Blacwell Publishing, Oxford U.K.

HOTSPOTS OF INTRODUCTION OF MARINE ALIEN SPECIES IN ITALIAN SEAS

S.I.B.M. Allochthonous Species Group [1] and Anna Occhipinti-Ambrogi (Coordinator) [2]*
[1] DET - Dipartimento di Ecologia del Territorio, Sezione di Ecologia, University of Pavia - occhipin@unipv.it
[2] Italian Society of Marine Biology (SIBM), Piazzale Mascagni 1, 57127 Livorno (Italy)

Abstract

A group of Italian marine biologists, covering most taxa, has been volunteering for collecting data on the distribution of alien species for several years. Starting from mid twentieth century, the lagoon of Venice and the Mar Piccolo di Taranto have resulted as the main hotspots of introduction, with 40 and 24 alien species, respectively. High numbers of introduced species are related to the presence of ports, marinas, aquaculture facilities, and of disturbed environmental conditions. The intensity of observations during scientific research programs may have added a bias in the evaluation of hotspots.

Keywords: Alien species, Species Introduction

Methods

Distribution of alien species has been assessed for the whole Italian coast, gathering literature records for the following taxa: Macrophyta, Porifera, Ctenophora, Cnidaria, Annelida, Mollusca, Crustacea, Picnogonida, Bryozoa, Tunicata and Vertebrata. Only species of "recent" introduction (after 1945) have been taken into account. The data have been checked by experienced taxonomists of the group, and compared to recent findings in the Mediterranean at large [1]. The number of total records has been calculated for the most representative locations, in order to identify sites where the introduction of alien species is more likely to occur along the Italian coast.

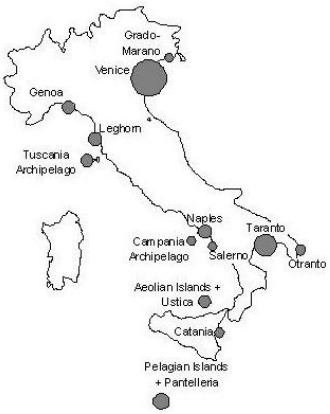


Fig. 1. Hotspots of introduction of alien species

Results & Discussion

Fig. 1 shows the main hotspots of introduction along the Italian coasts. Circle diameter is proportional to the number of introduced aliens. Three main hotspots can be clearly identified: the Lagoon of Venice, Taranto and Sicily. Fig. 2 shows the distribution of main ports, aquaculture sites and research institutions where SIBM members operate. It is obvious that in many cases there is a correlation between such factors, explaining the high numbers of recorded aliens. For example, 10-15 species have been recorded in each of the three sites with important commercial, military and recreational ports (Genoa, Naples, Otranto), having also been studied by experienced teams of marine biologists.

Lagoon of Venice (N-Adriatic Sea) - Venice is the main hotspot of introduction in Italy, and probably one of the most important in the whole Mediterranean: 40 alien species have been recorded here since 1945. In the Venice lagoon there is a unique combination of factors that have favoured such a massive introduction of non-native organisms. Venice hosts commercial and tourist ports, recreational marinas, aquaculture facilities. It has experienced rapid environmental changes over the past decades, with detrimental effects on the native biota, which has easily been replaced by invaders brought by shipping and aquaculture [2]. Furthermore, in Venice there is an uncommon concentration of research institutions displaying taxonomic expertise in most taxa and constantly monitoring its fragile ecosystem and its biota.

Taranto (N-Ionian Sea) - The Gulf of Taranto, containing the coastal lagoon "Mar Piccolo" and the second most important commercial port in Italy, is another hotspot, where 24 species of alien species have been introduced. As for the Lagoon of Venice, the factors that favour introductions are: shipping, aquaculture activity, degraded environment; an active research group based in Taranto [3] has performed routine surveys in the area.

Sicily (S-E Tyrrhenian and Straits of Sicily) - In the main island of the Mediterranean Sea, Sicily, also including smaller islands, the number of alien species has been increasing throughout the investigation period. While aquaculture industry is less developed there than in other parts of Italy, the geographic location might be viewed as the main determinant for the spotting of a large number of alien species: 11 in Catania, 13 in the S-Thyrrenian (Aeolian islands and Ustica), and 18 in the Straits of Sicily (Pantelleria and Pelagian islands). Located at the crossroads between the Eastern and Western sectors of the Mediterranean, Sicily is interested by an intense maritime traffic including fisheries and recreational fleets made of relatively small vessels. It also presents climatic conditions favouring the establishment of species until recently restricted in the Levantine waters. The presence of many marine biology centres based in Sicily is an obvious counterpart.

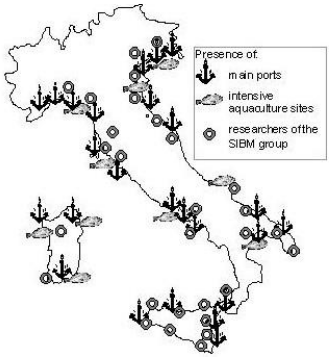


Fig. 2. Distribution of main ports, aquaculture sites and research institutions where SIBM members operate

Conclusions

A total of 163 alien species introduced has been recorded in Italian waters (Occhipinti-Ambrogi et al., in preparation), following a trend common for the whole Mediterranean Sea [1]. Some localities have yielded a very high number of species, and can be considered hotspots for present and future bioinvasions. Intense ship traffic in large ports and non voluntary transport of species connected with aquaculture activities are common in the three main hotspots examined, but the high number of species identified is also a consequence of the concentrated marine biological monitoring effort by expert teams.

References

1 - Galil B.S., 2009. Taking stock: inventory of alien species in the Mediterranean sea. *Biol. Inv.*, 11: 359-372.

2 - Occhipinti-Ambrogi A., 2000. Biotic invasions in a Mediterranean lagoon. *Biol. Inv.*, 2: 165-176.

3 - Cecere E. and Petrocelli A., 2004. Floristic and biogeographic considerations about the benthic macroalgal flora in the Gulf of Taranto. *Biogeographia*, 25: 7-18.

ANCHOVY AND SARDINE JUVENILE GROWTH DETERMINED USING THE SARDONE PROTOCOL: THE CASE OF THE GULF OF LIONS

Itziar Alvarez [1]*, Juan pablo Beltran [2], Beatriz morales- Nin [1] and Isabel Palomera [2]
[1] IMEDEA (CSIC) - itziar.alvarez@uib.es
[2] ICM (CSIC)

Abstract
This contribution is a first attempt for sardina (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) juveniles growth analysis in the Gulf of Lions. A first conclusion is that growth rates and increment widths are different depending on their hatching dates. Both clupeoid species growth is faster and higher when their hatch dates are closer to the warmer conditions, which is at the end of the spawning season for sardine and at the peak spawning for anchovy. In this period, environmental factors, such as SST, are more favorable for the early life stages growth.
Keywords: Growth, Life Cycles, Recruitment, Larvae

Introduction
In larval and early juvenile stages of fish, information on age structure can be used to clarify the effects of changes in the environment on growth and survival, and can result in an improved understanding of factors affecting recruitment success [1]. Rearing experiments under different environmental conditions provide valuable data on larvae growth but there is a limitation in rearing older individuals [1, 2, 3]. Long term series of data or different areas shall be used to determine the possible differences in growth determined by different environmental conditions in the wild. Sardone Project is aimed at developing a series of tools to better understand stock assessment and fishery management of small pelagic fish resources (anchovy and sardine) of the Mediterranean. The three major stocks and fisheries: the NW Mediterranean, the Adriatic and the Aegean have been chosen and a unique reading protocol and several calibration exercises were performed in order to minimize differences in interpretation between readers. All the differences in growth between the three areas will then be understood as induced by different environmental conditions. In this study we present the Gulf of Lions results, ready to compare with the other areas.

Material and Methods
Sardine and Anchovy juveniles from the different Sardone surveys were used to determine growth parameters. Sardine juveniles were caught at early August 2007, while anchovy juveniles were caught at early December 2007. Otolith preparation and interpretation were based on the protocols prepared by IMEDEA and AZTI for the SARDONE project [4]. The individual hatch date was calculated by subtracting its age (number of increments) from sampling date. According to [1] and [2], increment formation on anchovy and sardine otoliths starts from the hatching ring and the deposition is daily thereafter. The period in which all fish from each sampling period had hatched was divided into sub-periods and the evolution of increment widths was examined separately for each subperiod (subgroup).

Results and Discussion
a) Somatic growth
A total of 49 Sardine juvenile were analyzed, with TL ranging 65-97mm, the age interpreted range was between 101 and 120 days and the average growth rate was 1.01 mm day^{-1}. Based on the hatch dates, 3 groups were made and the evolution of increment widths was examined separately for each subgroup (Fig. 1). The three groups followed the same growth pattern but with differences in the slopes (JuvSp3 increments widths grew faster than JuvSp2 and JuvSp1), and differences in the maximum width reached.

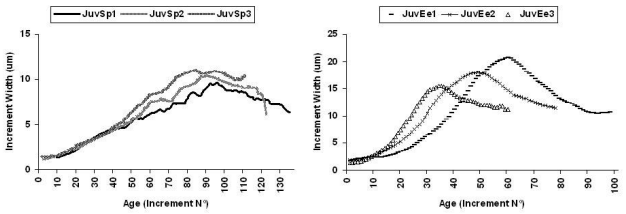


Fig. 1. Increment width (5-point running mean) by age (number of increments) for the different hatch-date grouped Sardine and Anchovy juveniles

Anchovy juvenile sample was bigger, 133 individuals were analyzed. Their TL ranged 48-95 mm, the age interpreted ranged between 42 and 101 days and the average growth rate 0.851 mm day^{-1}. Juveniles were grouped depending on their hatch date. The three groups had different growth rates, different maximum increment widths, and different period in life were the growth slows down (day 30, 45 and 60, figure 1)

b) *Environmental implications in growth*
For the sardine groups, as later they hatched in the season (Fig. 2), higher were their growth rates and higher the maximum increment width reached. The opposite occurs to the anchovy groups, where the higher growth rates and maximum increment widths reached belonged to the individuals hatched in September (JuvEe1). Around late November, the three groups growth patterns were synchronized.

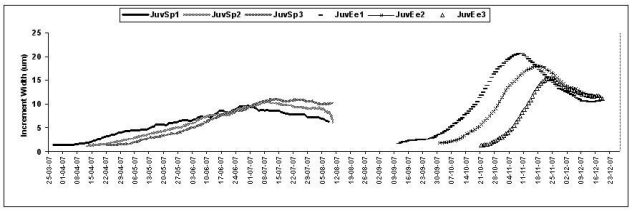


Fig. 2. Increment width (5-point running mean) for the hatch-date grouped *S. pilchardus* and *E. encrasicholus* juveniles

Environmental factors, such as sea surface temperature, which is higher in the central part of the year, might be responsible for those intra-area differences in growth. Growth plasticity in early life stages for both species depending on hatch date might also be present depending on the geographical area considered. Further comparisons between individuals hatched in different areas (different environments) will allow to identify key environmental factors affecting early life stages growth and will also allow to establish new growth patterns related to changes in those key factors.

References
1 - Aldanondo, N., Cotano, U., Etxebeste, E., Irigoien, X., Alvarez, P., Martinez de Murguia, A. & Herrero, D.L., 2008. Validation of daily increments deposition in the otoliths of European anchovy larvae (*Engraulis encrasicolus* L.) reared under different temperature conditions. *Fisheries Research*, 93: 257-264.
2 - Alemany, F. & Alvarez, F., 1994. Formation of initial daily increments in sagittal otoliths of reared and wild *Sardina pilchardus* yolk-sac larvae. *Marine Biology*, 121:35-39.
3 - Cermeno, P., Morales-Nin, B. & Uriarte, A., 2006. Juvenile European anchovy otolith microstructure. *Scientia Marina*, 70 (3): 553-557.
4 - Morales-Nin, Aldanondo, N. & Álvarez, I., 2010. Age determination of larval and juvenile small pelagics: The importance of a common protocol. 39TH CIESM Congress, Venice, Italy, 10-14 May.

DYNAMICS OF PARACARTIA SPECIES (CALANOIDA: COPEPODA) IN TWO PONDS OF THE SFAX SALTERN (TUNISIA) IN RELATION TO SALINITY

N. Annabi-trabelsi [1]*, R. Kobbi [1], W. Guermazi [1], G. Belmonte [2] and H. Ayadi [1]

[1] Université de Sfax, Faculté des Sciences de Sfax, Département des Sciences de la Vie. Unité de recherche UR/05ES05 Biodiversité et Ecosystème Aquatiques - neilaannabi@yahoo.fr

[2] Laboratory of Zoogeography and Fauna, Department of Biological and Technological Sciences and Technologies, University of Salento, 73100 Lecce, Italy

Abstract

The purpose of this work was to study the dynamics of two *Paracartia* species in two ponds in the Sfax saltern: A1 (salinity: 50.44±7.12) and A16 (71.51±13.46).*Paracartia latisetosa* and *P. grani* showed different population dynamics at the two different sites, but the influence of salinity could be ignored.

Keywords: Salinity, Brackish Water

Introduction

Paracartia latisetosa and *P. grani* are present in Sfax saltern. P. latisetosa is a seasonally dominant copepod species in northern Tunisian coastal waters [1]. P. grani is typical of highly turbid semi-enclosed systems in which food is often unavailable [2]. The aim of this work was to compare dynamics of this two species in two ponds of different salinity.

Material and methods

The Sfax solar saltern is located in the central-eastern coast of Sfax (Tunisia, 34° 390 0.100 N and 10° 420 3500 E). It is a confined ecosystem (sensu [3]) with evaporation exceeding water import. Sampling was carried out monthly from September 2007 to August 2008 in ponds A1 and A16. The zooplankton was collected by filtering 50l of water through 50 µm-mesh net, then transferred to a sterile 125 ml flask, and fixed with formaldehyde (5% final concentration) for further quantitative and qualitative analyses.

Results and discussions

The two ponds differed in the salt concentration. Salinity varied from 41.80 to 62.20 ‰ at A1 (average, 50.44 ± 7.12‰) and from 50.20 to 98.00‰ at A16 (average 71.51 ± 13.46‰). Temperatures were not greatly different in both ponds. They ranged from 11.50 to 29.00° C at A1 (average, 20.71±5.57° C) and from 12.50 to 30.00° C at A16 (average, 20.91±5.86° C).

The population density of *P. latisetosa* was higher in A16, whilst the population density of *P. grani* was higher in A1 (table. 1).

Tab. 1. Average annual abundances of *P. latisetosa* and *P. grani* (adult specimens) in two ponds (A1 and A16) of Sfax salt works

	A1	A16
P. latisetosa (× 10^3ind. m^{-3})	1.232	2.161
P. grani (× 10^3 ind. m^{-3})	5.135	2.915

At pond A1 total copepods abundance positively correlated with Salinity (r = 0,840), and negatively correlated with temperature (r = -0,610). At pond A16, total copepod and single species abundances did not correlate significantly with Salinity. Monthly abundance fluctuations of both species were different in both ponds (Fig. 1). *P. grani* was absent for 7 months in A16, and only 1 month in A1. *P. latisetosa* was absent for 6 and 4 months in A1 and A16 respectively.

Acartiidae are typical resting egg producers in confined areas [4]. *P. latisetosa* is well-known for the production of diapause eggs which allow it to over-winter [5], but the species was absent from the water column of both basins also from April to June 2008. Also *P. grani* is known to produce resting eggs [6]. Hence the intermittent population of these species is affected by the hatch of eggs, rather than by the development rate of juveniles under different salinity conditions. *Paracartia grani* drastically diminishes its abundance from A1 to A16. Notwithstanding, both ponds saw a demographic prevalence of that species. In A16, in fact, P. grani is only slightly more numerous than *P. latisetosa* which here shows an opposite trend, being more abundant than in A1. *P. latisetosa*, whose demographic growth seems to be directly correlated with Salinity in the two salt works studied, is also a typically brackish water species. Apart from features which interact in affecting the species reciprocal affirmation in such extreme environments, it emerges clearly that salinity could not be considered as the driving condition in assessing the *Paracartia* populations in confined environments**.**

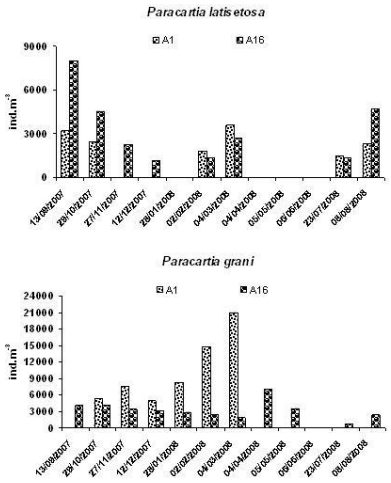


Fig. 1. Monthly variations of *Paracartia latisetosa* and *Paracartia grani* in Sfax salt works

References

1 - Annabi-Trabelsi, N., M.N. Daly-Yahia, M.S. Romdhane, & N.Ben Maïz., 2006. Seasonal variability of planktonic copepods in Tunis North Lagoon (Tunisia, North Africa). *Cah Biol. Mar*., 46, 325-333.

2 - Calbet A, E Saiz, X Irigoien, M Alcaraz, and I Trepat., 1999. Food availability and diel feeding rhythms in the marine copepods *Acartia grani* and *Centropages typicus J. Plankton Res*. 21: 1009-1015.

3 - Guelorget 0. and Perthuisot J.-P., 1992. Paralic ecosystems – Biological organization and functionning. Vie Milieu, vol. 42: 215-251.

4 - Mauchline J., 1998. The biology of calanoid copepods, Advances in Marine Biology 33: 710 pp.

5 - Belmonte G. and A. C. Pati., 2007. Hatching rate and diapause duration in eggs of *Paracartia latisetosa* (Copepoda: Calanoida). *J. Plankton Res* 29: 39-47.

6 - Guerrero F. and Rodriguez V., 1998. Existence and significance of *Acartia grani* resting eggs (Copepoda: Calanoida) in sediments of a coastal station in the Alboran Sea (SE Spain). *J. Plankton Res*., 20: 305-314.

BIODIVERSITE DES DIGENES PARASITES DE QUELQUES SPARIDES PROVENANT DE LA LAGUNE DE BIZERTE

Rym Antar [1], Tahani Chargui [2], Najoua Trigui El Menif [2] and Lamia Gargouri Ben Abdallah [1]*

[1] Unité de Biologie, d'écologie et de parasitologie des organismes aquatiques, Faculté des Sciences de Tunis, Manar II, 2082, Tunisie - lamiagargouri@yahoo.com

[2] Laboratoire de Biosurveillance et de l'Environnement, Faculté des sciences de Bizerte, 7021 Zarzouna, Tunisie

Abstract

L'examen de 69 individus appartenant à 4 espèces de poissons sparidés provenant de la lagune de Bizerte, a permis de recenser 8 espèces de parasites (*A. stossichi, B. israelensis, H. pycnoporus, L. album, L. pegorchis, M. monorchis, R. fractum* et *S. pagelli*). La richesse spécifique de ces sparidés est faible. La comparaison de la faune digénétique des sparidés lagunaires avec celle des poissons marins montre une diversité et une fréquence plus faible dans le premier biotope.

Keywords: Biodiversity, Fishes, Lagoons, Parasitism

Introduction

En Méditerranée, les travaux de recherche sur les digènes ont surtout concerné les poissons téléostéens marins [1-6] le milieu lagunaire a été peu étudié. Le manque de données sur la faune digénétique lagunaire nous a incité à entreprendre l'étude des trématodes de quelques sparidés provenant de la lagune de Bizerte et d'effecteur une analyse comparative avec les données disponibles concernant le golfe de Tunis.

Matériel et méthodes

Les poissons examinés (*Boops boops, Pagellus erythrinus, Pagrus pagrus, Spondilyosoma cantharus*), provenant de la lagune de Bizerte, située au nord-est de la Tunisie, représentent un effectif total de 69 spécimens. Le poids et la taille de chaque individu ainsi que la date sont notés sur une fiche topographique parasitaire. L'animal est, ensuite, incisé médio-ventralement à partir de l'anus. Le tube digestif prélevé est déroulé et divisé en différentes parties (œsophage, estomac, caecums pyloriques, intestin antérieur, intestin moyen, intestin postérieur et rectum). Chaque partie est placée dans une boîte de Pétri contenant une solution physiologique, puis disséquée et examinée.

Les mésoparasites prélevés sont déterminés, dénombrés et leurs localisations notées. Ils sont, par la suite, soit directement étudiés *in vivo* au microscope, soit préparés pour une étude ultérieure *in toto*. La nomenclature appliquée pour la détermination des valeurs épidémiologiques est celle utilisée habituellement [7-8].

Résultats et discussion

L'examen du tube digestif des poissons récoltés nous a permis de recenser 8 espèces de trématodes appartenant à 6 familles distinctes : Faustulidae (*Bacciger israelensis*), Fellodistomidae (*Steringotrema pagelli*), Gyliauchenidae (*Robphildollfusium fractum*), Hemiuridae (*Aphanurus stossichi*), Monorchiidae (*Monorchis monorchis*) et Lepocreadiidae (*Holorchis pycnoporus, Lepocreadium album, Lepocreadium pegorchis*).

L'étude de la distribution de ces parasites au sein du tube digestif des différents hôtes montre que *B. israelensis* et *R. fractum* se limitent respectivement à l'intestin moyen et l'intestin antérieur, d'autres espèces (*A. Stossichi, H. pycnoporus, L. album, M. monorchis* et *S. pagelli)* ne semblent pas montrer de préférence biotique et sont donc présents dans différentes parties de l'intestin. L'examen de la répartition des espèces parasites qui fréquentent divers sparidés montre que *L. pegorchis* n'occupe pas le même microbiotope chez les deux espèces d'hôtes ; en effet, ce parasite colonise les caecums pyloriques chez *B. boops* et l'intestin moyen chez *P. erythrinus*. *L. album*, qui se limite à l'intestin antérieur chez *P. pagrus*, semble étendre son aire de répartition aux caecums pyloriques chez *S. cantharus* Ceci est sans doute en relation avec le polymorphisme du tube digestif des hôtes et leur résistance différentielle aux parasites [9].

Concernant la richesse spécifique de ces sparidés, la plus importante est enregistrée chez *B .boops* (4 espèces). *A. Stossichi* semble être le parasite dominant chez ce poisson. *S. cantharus* héberge 3 espèces de digènes. La parasitofaune de ce sparidé est dominée par *S. pagelli* et à moindre degré par *L. album*. La diversité de la faune digénétique de *P. pagrus* et *P. erythrinus* est faible ; elle ne dépasse pas, respectivement, 1 et 2 espèces.

L'examen de l'ensemble des parasites présents dans un individu hôte a révélé que la majorité des espèces hôtes loge une seule espèce de parasite et rarement deux ou trois espèces ; les infracommunautés sont donc pauvres.

La comparaison de la faune digénétique des poissons lagunaires avec celle des poissons marins [10] montre une diversité et une fréquence généralement plus faible dans la lagune de Bizerte. Ceci peut être en relation avec une faible fréquence des hôtes intermédiaires dans le biotope, à une action néfaste de la pollution sur les hôtes intermédiaires et les stades libres de parasites ainsi qu'à un faible effectif de l'échantillonnage. Par ailleurs, nous signalons trois nouveaux hôtes dans la lagune de Bizerte, deux (*B. boops, P. erythrinus*) pour *L. pegorchis* et un (*P. pagrus*) pour *L. album.*

References

1 - Sey O., 1970. Parasitc helminths occuring in Adriatic fishes. Part II (flukes). *Acta Adriat.,* 13 (6): 3-15.

2 - Fischthal J.H., 1982. Additional records of digenetic trematodes of marine fishes from Israel's Mediterranean coast. *P. Helm. Soc. Wash.,* 49: 11-23

3 - Bartoli P. & Bray R.A., 1996. Description of three species of *Holorchis* Stossich, 1901 (Digenea: Lepocreadiidae) from marine fishes off Corsica. *Syst. Parasitol.,* 35: 133-143.

4 - Sasal P., Niquil N. & Bartoli P., 1999. Community structure of digenean parasites of sparid and labrid fishes of the Mediterranean sea: a new approach. *Parasitol.,* 119: 635–648.

5 - Bartoli P., Gibson D.I. & Bray R.A., 2005. Digenean species diversity in teleost fish from a nature reserve off Corsica, France (western Mediterranean), and a comparison with other Mediterranean regions. *J. Nat. Hist,* 391: 47-70.

6 - Ternengo S., Levron C. & Marchand B., 2005. Metazoan Parasites in Sparid fish in Corsica (Western Mediterranean). *Bul. Eur. Ass. Fish Pathol.,* 25 (6): 262-269.

7 - Margolis L., Esch G.W., Holmes J.C., Kuris A.M. and Schad G.A., 1982. The use of ecological terms in parasitology. *J. Parasitol.,* 68, 1: 131-133.

8 - Bush A. O., Lafferty K. D. Lotz J. M. and Shostak A. W., 1997. Parasitology meets ecology on its own terms: Margolis et al. Revised. *J. Parasitology,* 83, 4: 575-583

9 - Crompton D. W. T., 1973. The sites occupied by some parasitic helminths in the alimentary tract of vertebrates. *Biol. Rev.,* 48: 27-83.

10 - Gargouri Ben Abdallah L. and Maamouri F., 2008. Digenean fauna diversity in Sparid fish from Tunisian coasts. *Bull. Eur. Ass. Fish Pathol*., 28 (4), 129-137.

ANALYSIS OF SIGHTINGS OF MONK SEAL (*MONACHUS MONACHUS*, HERMANN1779) IN THE CROATIAN PART OF THE ADRIATIC 2006-2009

J. Antolovic [1]*, N. Antolovic [1], M. Antolovic [1], E. Coppola [1], G. Pecchiar [1], M. Piccoli [1] and M. Hervat [1]
[1] The Mediterranean Monk Seal Group, The Association for Reasearch and Protection of Nature, Krešimirov trg 15, 10000 Zagreb, Croatia - jasna.antolovic@zg.t-com.hr

Abstract
The monk seal (*Monachus monachus*,Hermann1779) belongs to the order Pinnipeds (*Pinnipedia*), family seal (*Phocidae*), sae monk genus (*Monachus*). The total population amounts to about 350 individuals in smaller, isolated and endangered groups.The aim,during a four-year systematic research (2006-2009) the data on the sightings of monk seal in the Croatian part of the Adriatic Sea have been collected.The results,the sightings were reported in the area (79 sights). According to the systematic research of the habitat (21 caves) of the open-sea islands and the Adriatic coast and their recordings, it has been determined that a monk seal stays in them.Conclusion,For the survival of the species it is essential to protect areas of open-sea islands in the Adriatic and to place infrared cameras inside the caves thus giving us the insight of their use.
Keywords: Adriatic Sea, Islands

Introduction
The monk seal (*Monachus monachus*, Hermann 1779) belongs to pinnipeds (*Pinnipedia)*, of family seal (*Phocidae)*, sea monk genus (*Monachus)*. It lives in small groups at the Mediterranean and Adriatic [1]. It uses caves which have a sunny beach or stone plaques as habitats [3]. In the Atlantic it leaves along the West Sahara coast, Mauritania and Morocco. They stay in the litter area. Due to its sensitivity, rarity and critical status it belongs to ten most endangered mammals of the world. [2]. Once, the number of the individuals in the Adriatic was 64 and today this number has drastically decreased[5]. It feeds on molluscs, cephalopods and fish. The population of the species is decreasing. The exact cause is not known. It is presumed that it is caused by killing of sexually mature individuals and decreased reproduction activity and mortality due to viral disease. The biology of the species is still quite unknown [4].

Material and Methods
The aim of a four year (2006 – 2009) systematic research is gathering data on sights of the monk seal in the Croatian part of the Adriatic and to research new caves/habitats of the species. The interest group – fishermen are given a questionnaire/postcard during a terrain visit of the researched area at the Adriatic. The gathered data on the sights of the individual and their analyses will enable new ideas on the behaviour of the individual during meeting and time of keeping back/observation.

Results
The four year systematic research of the habitat (21 caves) of open-sea islands and the Adriatic coast and their recording, it has been determined that a monk seal stays in them. The monk seal is present in the Adriatic Sea. The sights were reported in the area of the whole Croatian part of the Adriatic (79 sights, picture 1). The photoidentification method of video records and photographs of the monks seals was used. Based on these results it is presumed that several various individuals have been living in this area of the Adriatic (a male, a female and a young of the animal) and individuals for which a gender could not have been determined by photoidentification.



Fig. 1. Sightings of the Monk Seal (*Monachus monacshus*) in the Croatian part of the Adriatic 2006 - 2009

Discussion
The public became interested in reporting their sights of the species by educational methods/lectures, distributions of questionnaires on the sights of monk seals. Simultaneous sights in various areas indicated that a smaller population of the monk seal lives in the Adriatic in two colonies of 5-7 individuals. Material evidence is video records and photographs of individuals taken in caves or near them, in various areas of the Croatian part of the Adriatic. Survival of the species can be obtained by establishing specially protected areas of open sea islands of the Adriatic and placing infrared cameras inside caves which would give us the insight into their use.

References
1 - Jardas I, Draganovic E., 1987. *Rasprostranjenost, brojnost i zaštita populacije sredozemne medvjedice (Monachus monachus Hermann, 1779) s posebnim osvrtom na Jadransko more*. Sarajevo: Akademija nauka i umjetnosti Bosne i Hercegovine. : 83: 81-94.
2 - Sergeant D, Ronald K, Bulova J, Berkes F., 1978. The Recent Status of Monachus monachus, the Mediterranean Monk Seal. *Biol Conserv*, England. : 4: 259-287.
3 - Antolovic J, Huber Đ., 1997. Staništa sredozemne medvjedice (*Monachus monachus* Hermann, 1779) u podrucju Viškog otocja. *Zbornik sažetaka priopcenja. Šesti kongres biologa Hrvatske*. Zagreb: Hrvatsko biološko društvo: 269-369.
4 - Cebrian D, Anagnostopoulos A., 1992. *Status of the population and habitat of the Mediterranean monk seal in Cyclades islands first approach.* Athens: Environmental Research Bureau.
5 - Antolovic J, Antolovic M, Antolovic N, Furlan B, Adamic-Antolovic Lj, Antolovic R, Cok I., 2006. Videnja sredozemne medvjedice (*Monachus monachus)* u hrvatskom dijelu Jadrana s posebnim osvrtom na populaciju pucinskih otoka. Zbornik sažetaka priopcenja. Deveti kongres biologa Hrvatske. Zagreb: Hrvatsko biološko društvo. 387-388.

BIODIVERSITY OF ZOOBENTHOS ASSOCIATED WITH A *CLADOCORA CAESPITOSA* BANK IN THE NORTH AEGEAN SEA

Chryssanthi Antoniadou [1]* and Chariton Chintiroglou [1]
[1] Aristotle University, School of Biology, department of zoology, Thessaloniki, 54124, Greece - antonch@bio.auth.gr

Abstract
Biodiversity of zoobenthos associated with a *Cladocora caespitosa* bank was assessed in the north Aegean Sea, during summer 1998. Overall, 31 megabenthic and 54 macrobenthic species were recorded, 58 of which are reported for the first time to live in association with *C. caespitosa*; thus, the biodiversity of *C. caespitosa* assemblages is increasing to 286 species. 12 species dominated in frequency and abundance and the estimated diversity indices gained high values. These results indicate that the associated assemblages are probably differently structured among individual colonies and banks.
Keywords: Aegean Sea, Biodiversity, Rocky Shores, Zoobenthos

Introduction
Cladocora caespitosa (Linnaeus, 1767) is a colonial zooxanthellate Scleractinian, occurring throughout the Mediterranean [1]. The species usually forms subspherical colonies of small size [2]. Occasionally and mostly to the SE Mediterranean, these formations can be of very large size, described under the term banks [3]. Such biogenic structures, recently considered as ecosystem engineers, have been intensively studied [2, 3] but very few data exists about the structure of the associated benthic assemblages [4]. Accordingly, the aim of the present work is to contribute to the study of the fauna associated with a *C. caespitosa* bank, by providing information about species richness and distribution.

Materials and Methods
The study was conducted at the north Aegean Sea (Figure 1), where a large bank (3m high and 5 m long) has been described at 20m depth. Sampling was carried out in summer 2008 by SCUBA diving and involved: (1) the assessment of megabenthic diversity using visual census along transects, (2) the assessment of abundance of the most conspicuous, epibenthic, sessile animal species, applying the method of randomly placed frames, and (3) the collection of quantitative macrobenthic samples, by totally scraping of the substrata using a quadrate sampler (5 replicates 400 cm^2, each). The collected material was sorted, identified at species level and counted. Common biocoenotic methods were employed to analyze data.

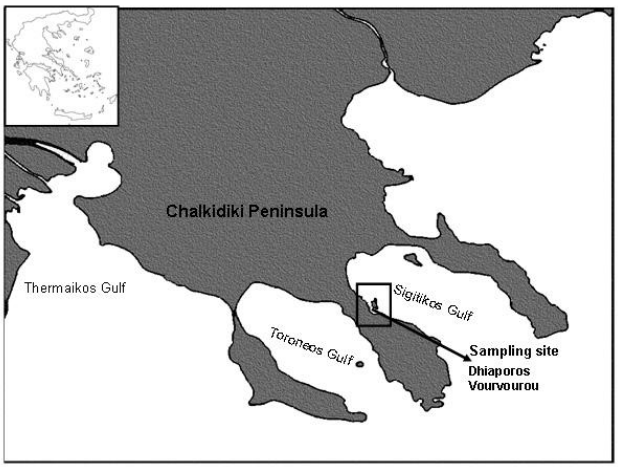


Fig. 1. Map of the study area where *C. caespitosa* bank is located

Results and Discussion
Thirty-one megabenthic animal species were recorded, 3 of which have been previously reported from *C. caespitosa* colonies [4]. The most conspicuous and abundant of these species were *Agelas oroides* (22 individuals m^{-2}), *Axinella cannabina* (5 individuals m^{-2}), *A. verrucosa* (2 individuals m^{-2}), *Chondrosia reniformis* (5 individuals m^{-2}), *Diplastrella bistellata* (19 individuals m^{-2}), *Petrosia ficiformis* (11 individuals m^{-2}), *Ircinia variabilis* (9 individuals m^{-2})and *Halocynthia papillosa* (1 individuals m^{-2}). All these species are very common at sublittoral cliffs in the Aegean Sea [5]. Fifty-four macrobenthic animal species were recorded, 24 of which have been previously reported to live in association with *C. caespitosa* colonies [4]. Polychaeta was the most speciose and abundant group, followed by Gastropoda and Peracarida (Figure 2).

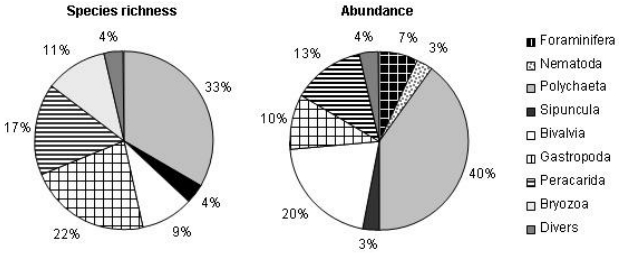


Fig. 2. Taxa contribution to species richness and abundance at the studied *C. caespitosa* bank

The species *Hiatella arctica, Syllis hyalina, Nereis rava, Trypanosyllis zebra, Vermilliopsis infundibulum, Microdeutopus anomalus, Lycidice ninetta, N. zonata, S. prolifera, Modiolus adriaticus, Phascolosoma granulatum, Caecum trachea* and *Paranthura nigropunctata* dominated in terms of frequency of appearance and abundance. Diversity indices gained high values, 4.83 and 0.86 for Shannon-Wiener and Pielou's Evenness, respectively. According to literature data 16 megabenthic and 212 macrobenthic species inhabit *Cladocora caespitosa* colonies at the north Aegean Sea [4]; including the results of the present study, the total number of species associated with *C. caespitosa* is increasing to 286 (242 macrobenthic and 44 megabenthic species). It seems also that the associated assemblages are probably different structured among individual colonies and banks. Considering that *C. caspitosa* is affected by necrosis under increasing temperature [6] further research is required since such mortality events could have cascade effects to the associated assemblages.

References
1 - Zibrowius H., 1980. Les Scléractiniaires de la Méditerranée et de l'Atlantique nord-occidental. *Mém. Inst. Océanogr.*, 11: 1-284.
2 - Morri C., Peirano A. and Bianchi C.N., 2001. Is the Mediterranean coral *Cladocora caespitosa* an indicator of climatic change? *Archo Oceanogr. Limnol*., 22: 139-144.
3 - Peirano A., Bianchi C.N. and Morri C., 1999. Skeleton growth and density pattern of the temperate, zooxanthellate scleractinian *Cladocora caespitosa* from the Ligurian Sea (NW Mediterranean). *Mar. Ecol. Prog. Ser.*, 185: 195-201.
4 - Koukouras A., Kühlman D., Voultsiadou E., Vafidis D., Dounas C., Chintiroglou C. and Koutsoubas D., 1998. The macrofaunal assemblage associated with the Scleractinian coral *Cladocora caespitosa* (L.) in the Aegean Sea. *Ann. Inst. Oceanogr.*, 74: 97-114.
5 - Antoniadou C., Voultsiadou E. and Chintiroglou C., 2006. Sublittoral megabenthos along cliffs of different profile (Aegean Sea, Eastern Mediterranean). *Belg. J. Zool*., 136: 69-79.
6 - Metalpa R.R., Bianchi C.N., Peirano A. and Morri C., 2005. Tissue necrosis and mortality of the temperate coral *Cladocora caespitosa*. *Ital. J. Zool*., 72: 271-276.

THERMAL POLLUTION IMPACT ON BENTHIC FORAMENIFERAL ASSEMBLAGES AS ANALOG TO GLOBAL WARMING, SE MEDITERRANEAN SHORE (ISRAEL)

Ruthie Nina Arieli [1], Sigal Abramovich [1], Ahuva Almogi-Labin [2]* and Barak Herut [3]
[1] Geological Survey of Israel - almogi@gsi.gov.il
[2] Deparment of Geological and Environmental Sciences, Ben Gurion University
[3] Israel Oceanographic & Limnological Research, Israel

Abstract

This study examines the effects of heated water originating from the "Orot Rabin" power plant on benthic foraminifera known to be sensitive bioindicators of environmental change. We performed 10 sampling campaigns during a period of one year, at 4 stations located along a temperature gradient of approximately 10 °C. The SST along the transect vary between 25/18 °C in winter, and 36/31 °C in summer. A significant negative correlation was found between SST and benthic foraminiferal abundance, species diversity and species richness. If this research is taken as a model, it may be concluded that global warming has a primary negative effect on foraminifera assemblage characteristics and thereby most likely on other marine organisms as well.

Keywords: Foraminifera, Thermal Pollution, Eastern Mediterranean, Biodiversity

Over the past several decades public and scientific awareness to global warming has increased significantly. As a result, many studies have examined the potential deleterious effect of global warming on the natural environments, though few have explored its effect on marine living organisms in the southeast Mediterranean Sea. As of today, an accepted forecast for the next two decades is that ocean temperatures will rise at a rate of 0.2 °C per decade [1]. The current rate of warming in the Mediterranean Sea is in accordance with the rate of global warming and stands at 0.028 °C/year [2].

This study was set to examine the effects of increased SST on benthic foraminifera known to be sensitive bioindicators of environmental change. The thermal patch originating from a power plant on the coast of Israel was chosen as a sampling area for this research, since it presents a unique small-scale analog for the expected future rise in sea surface temperatures. Ten monthly sampling campaigns, were performed in 4 stations located along a temperature gradient of approximately 10 °C, from the discharge site of the heated seawater to a few kilometers south. Benthic foraminifera were collected from a shoreface complex of macroalgae and sediment trapped within. The SST varied between winter, 25/18 °C and summer, 36/31 °C along the transect (Fig. 1). During the summer, the addition of the temperature anomaly to the already extreme summer temperatures becomes a threat.

The natural seasonal pattern in this near-shore environment, depicted best by station 4 located beyond the thermal patch, shows that foraminifera reach maximal abundance in winter and spring, ~2 months prior to a deeper (~40 m) inner shelf habitat, probably due to faster warming of the shallow waters. A significant negative correlation was found between SST and benthic foraminiferal assemblage characteristics. The abundance and species diversity show negative correlation with the SST anomaly throughout most of the sampling period, though the species diversity was not as significant as the abundance. The total foraminiferal abundance was significantly lower at the thermally polluted stations, especially during the summer, but also throughout the entire year, indicating that the thermal pollution has a detrimental effect on benthic foraminifera, irrelevant to the natural cyclic changes in SST. The foraminiferal abundances decrease as the SST rises (Fig. 1), reaching minimal abundances when the SST rises above 30 °C, indicating that this temperature maybe a critical threshold above which foraminifera growth and reproduction are severely retarded.

Species richness reached extremely low values at the thermally polluted stations during the summer, with a minimum of 3 species compared to a maximum of 24 in the natural, unaffected station. This indicates that some species have adapted to the elevated temperatures better than others. The foraminiferal assemblage at the sampling area is composed mostly of epiphytic species. A total of 42 species belonging to 24 genera were identified with six species dominating the assemblage throughout most of the sampling period. These species appeared to have different seasonal patterns, out of the six dominant species *Rosalina globularis*, *Tretomphalus bulloides* and *Textularia agglutinans* show a clear preference to the winter months, while species belonging to the genus *Lachlanella* reach maximum abundances in spring and *Pararotalia spinigera* in summer. The temperature tolerance varied considerably among the different species with some being more tolerant to the raised SST than others. The miliolids, *Lachlanella* sp. 1 and sp. 2 seem to have high tolerance to the elevated SST and even survived the most extreme summer temperatures at the thermally polluted stations.

In this research we show that even a rise, as small as 2 °C, in SST can have serious ramifications on the benthic communities living in the near shore environment. If foraminifera are affected to such an extent it is not unlikely that other more developed marine creatures will be negatively affected as well, either directly by the rise in SST or via the decrease in organisms lower down the marine food chain, such as foraminifera. If this research is taken as a model, it may be concluded that global warming has a primary negative effect on foraminifera assemblage characteristics and thereby most likely on other marine organisms as well.

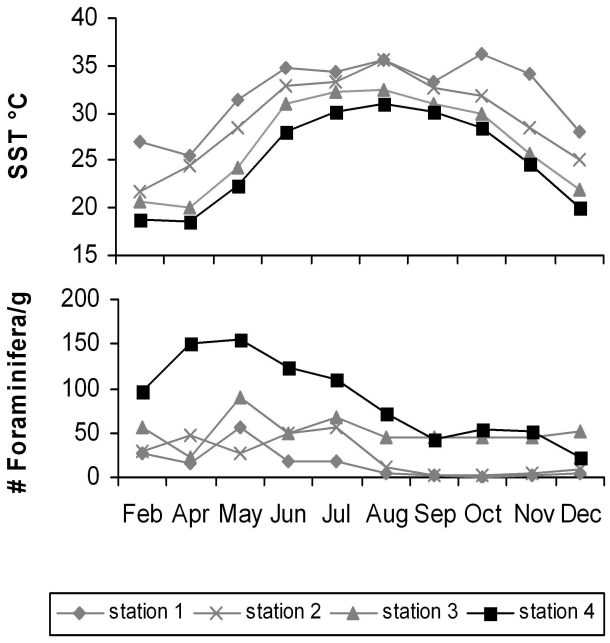


Fig. 1. The SST and the average foraminiferal abundance at the 4 stations throughout the sampling period

References

1 - IPCC (Intergovernmental Panel on Climate Change)., 2007. Climate Change 2007: The physical Science Basis. WMO/UNEP.

2 - Stips, A. K., Garcia- Gorriz, E. and Bolding, K., 2006. Variability of the Mediterranean Sea surface temperature. *Geophysical Research Abstracts* 8: 04160.

THE OCCURRENCE OF THE JINGA SHRIMP, *METAPENAEUS AFFINIS* (H. MILNE EDWARDS, 1837) (DECAPODA, PENAEIDAE) – A COMMERCIALLY VALUABLE ALIEN

Ilker Aydin [1]* and Cengiz Metin [2]
[1] Ege University Faculty of Fisheries - ilker.aydin@ege.edu.tr
[2] Ege University Research and Application Centre of Underwater

Abstract
In 2000 the use of beach seining and trawling was prohibited in the Bay of Izmir, on the Aegean coast of Turkey. Ever since artisanal fishermen have been using stationary gear such as gillnets and longlines. Trammel nets have been used between May and October to fish the native Mediterranean prawn Melicertus kerathurus. In 2008 large numbers of an alien prawn, *Metapenaeus affinis*, were collected for the first time in the inner part of the bay. Because of their higher value and longer fishing season than the native prawn, fishermen began to exploit them.
Keywords: Alien species, Aegean Sea, Crustacea, Fisheries

Introduction
Metapenaeus affinis (H. Milne-Edwards) is an Indo-West Pacific species which ranges from the Arabian Gulf to the Malay Archipelago [1]. It is commercially valuable in some Asian countries and in the Persian Gulf. Trawlers, trammel nets, beach and boat seines are used to catch this species. Soon after the population of the jinga shrimp was discovered in Izmir bay, local fishermen began catching them using shrimp trammel nets.
Extensive studies conducted in 2003-2005 of the commercial prawn trammel net fishery targeting the native Mediterranean prawn *Melicertus kerathurus* (Forskål, 1775) in Izmir Bay have revealed no alien prawn either in the landed catch or in the discard [2,3].The aim of this study was try to determine the fishing method and technial details of the trammel net which used to capture Jinga shrimp.

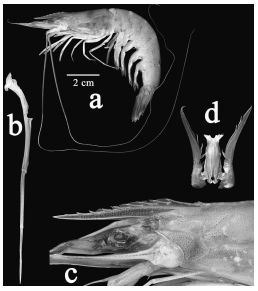


Fig. 1. ***Metapenaeus affinis*** **a) Lateral view of male, b) 5th Pereiopod of male, c) Rostrum of male d) petasma and 1st pereiopods (Photo: I.AYDIN)**

Material and Methods
This study was realized in Izmir Bay with a commercial F/V *EFSANE 6* between April 2008-October 2009. Depth of the fishery areas varied 8-12 meter.The shrimp trammel nets which are popular for the bay were used to collect specimens[4].

Results and Discussion
Jinga shrimp specimens were occurred in April 2008 in Izmir Bay where is the eastern shore of the Aegean Sea [5].Trammel nets for jinga shrimp set in the inner part of the bay catch other species as well: Whiting (Merlangius merlangus), meagre (Argyrosomus regius), red mullet (Mullus barbatus), chub mackerel (Scomber japonicus), squid (Loligo vulgaris), sole (Solea solea) are the most commercially valuable abundant species in all seasons. Twaite shad (Alosa fallax) and annular sea bream (Diplodus annularis) are commercial between May – September during the closure of trawling and purse seining.
72 species were identified from prawn trammel nets in the bay of Izmir, and 46 of them are considered discards [2]. We identified 8 species collected in the jinga shrimp fishery in the bay and only two of them are discards during the trawl fishing season. The difference in number of species may be due to the location of the fishery, which is in the innermost part of the bay, closer to the harbour of izmir, whereas M. kerathurus is fished in the middle and outer part of the bay.
The fishermen use 8-9 pieces of netting per fishing operation. The average catch was ere 18, 26, 12 kg respectively in spring, summer and autumn of 2008, and 10, 15, 3 kg respectively in 2009. In winter the prawn fishery does not operate, however other types of nets are set for sparid fish and occasionally few individuals are caught as well. The jinga shrimp fishery lasts from April to October.

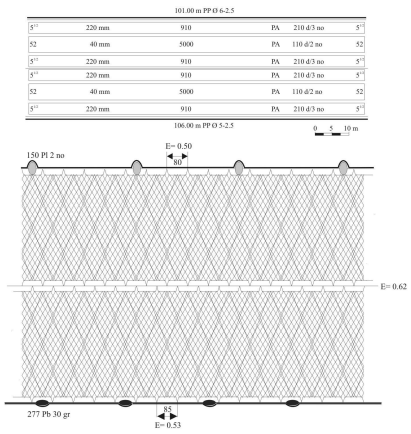


Fig. 2. Technical detail of trammel net, used for jinga shrimp in Izmir Bay

Acknowledgements : The authors would like to thank Prof. Dr. Bella S. GALIL for her support and Mr. Salih Öztürk for providing the specimens.

References
1 - Holthuis,. L.B., 1980. FAO species catalogue . Vol.1. shrimps and prawns of the world. An annotated catalogue of species of interest to fisheries. FAO Fish.Synop., (125)Vol.l:271 p.
2 - Gökçe, G. & C. Metin., 2007. Landed and discarded catches from commercial prawn trammel net fishery. *J. Appl. Ichthyol*., 23: 543-546.
3 - Akyol, O., 2008. Fish by-catch species from coastal small-scale shrimp trammel net fishery in the Aegean Sea (Izmir Bay, Turkey) . *J. Appl. Ichthyol*., 24: 339-341.
4 - Gökçe, G., C., Metin, I., Aydin, I., Bayramiç., 2005. The common squid (*Loligo vulgaris* Lam., 1798) fishery with shrimp trammel net in Izmir Bay. Ege University *Journal of Fisheries & Aquatic Sciences*, 22 (3–4); 419–422, 2005.
5 - Aydin, I., K., Bakir, B. S., Galil., 2009. The first record of the Jinga shrimp *Metapenaeus affinis* (H. Milne Edwards, 1837) (Crustacea: Decapoda: Penaeidae) from the Mediterranean Sea. *Crustaceana* 82 (8): 1091-1095.

A SIMPLIFIED VISUAL CENSUS METHODOLOGY TO DETECT VARIABILITY TRENDS OF COASTAL MEDITERRANEAN FISHES UNDER CLIMATE CHANGE SCENARIOS

Ernesto Azzurro [1]*, Francesc Maynou [2] and Paula Moschella [3]
[1] ISPRA - High Institute for Environmental Protection and Research - eazzurr@tin.it
[2] ICM-CSIC, Passeig Maritim de la Barceloneta 37-49, 08003 Barcelona, Spain
[3] CIESM - The Mediterranean Science Commission - Monaco

Abstract
Here we tested a simplified visual census methodology in which the sampling unit consisted of snorkeling trials of 5 minutes. Censuses were conducted over 4 different Mediterranean locations, according to a hierarchical sampling design. Results discriminated the assemblages at different spatial levels and confirmed the importance of Latitude gradient for the distribution of *T. pavo* and *S. cretense*. Aim of this contribution is to discuss the potential of this method to detect variability trends of Mediterranean fish species.
Keywords: Fishes, Sampling Methods, Global Change

Introduction
The contemporary change in the species geographical ranges is one of the most apparent signals of climate warming worldwide [1] and now in the Mediterranean Sea, a number of thermophilic coastal fish species seems to be extending their distribution and increasing in abundance [2]. Our capacity to monitor and understand this phenomenon is limited by the pragmatic constraints that arise in encompassing large spatial and temporal scales, being the most of information generally given by the sum of sporadic observation. As recently emerged by a CIESM workshop [2], to select a reliable network of variables, to use simple methods and a minimal investment in extracting local information can help much in overcome these difficulties. Therefore, on the basis of these guidelines, we propose a simplified visual census methodology to monitor a set of coastal fish species. The method was specifically intended to be used by a wide group of observers over large geographical scales and, hopefully within long time series.

Materials and Methods
Our sampling unit (count) consisted of a snorkelling transect of 5 minutes, parallel to the shore. During this time, the observer takes abundance data for a set of species (i.e. *Epinephelus marginatus*, *Caranx cysos*, *Thalassoma pavo*, *Coris julis*, *Sparisoma cretense*, *Serranus scriba*, *Serranus cabrilla*, *Sarpa salpa*), that were chosen for their wide distribution and different affinity to temperature. The study, performed during September-October, 2009, was limited to rocky bottoms, in order to minimize the sources of variability. The sampling design consisted of 2 different latitude ranges (low and high) with 2 locations nested in each of it, 3 sites nested in each location and 4 replicate trials, for a total of 48 fish counts (Fig. 1). Data were overall square root transformed, univariate and multivariate analyses were performed by using the PRIMER 6+PERMANOVA software package.

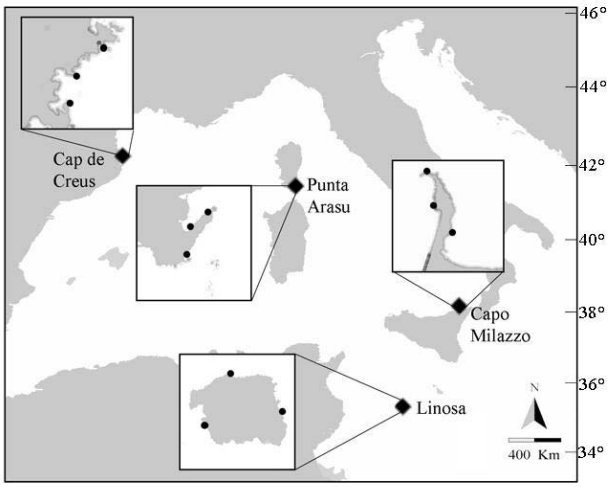


Fig. 1. Study locations (black diamonds) (low latitude: Linosa and Capo Milazzo; high latitude: Punta Arasu and Cap de Creus) and sites (black circles).

Results and Discussion
We counted 2257 individuals overall. According to PERMANOVA analysis (Tab. 1), significant differences in the fish assemblages were detected at the spatial scales of 'locations' and 'sites' but no significant differences were found for the factor 'latitude'.

Source	df	SS	MS	Pseudo-F	P(perm)
Latitude=La	1	23920	23920	1.9264	0.3388
Location (La)	2	24834	12417	19.583	0.0001
Sites(Location(La))	8	5072.5	634.06	1.7738	0.0455
Res	36	12868	357.45		
Total	47	66695			

Fig. 2. Permutational multivariate analysis of variance based on the Bray Curtis dissimilarity measure for square root transformed abundance data.

The lack of statistical significance for the factor 'latitude' can be explained by a inadequate number of replicates at the location level. Therefore we proceeded with the SIMPER analysis that indicated *T. pavo* (Contribution to the dissimilarity 28.79%), *S. salpa* (24.17%) and *S. cretense* (13.72%) as mostly important to discriminate between low and high latitudes. *T. pavo* and *S. cretense* are species that are typical of the south Mediterranean and these results confirmed the importance of latitude in shaping their distribution. According to 3-way PERANOVA, *T. pavo* resulted to vary significantly according to the factor latitude (Pseudo F= 120.71; p = 0.461), but also with the factors 'location' and 'site'. In sum, despite the poor quality of information that was extracted by each single trial, these preliminary data were effective in to discriminate spatial differences at the level of location and sites. The study represented an useful test to plan future sampling and hopefully an incentive to discuss the potential of this simple method to detect variability trends of Mediterranean fish species. We believe that powerful information could be obtained by means of a structured sampling design where many other similar observations are assembled to build a wider-scale picture. The census method was simplified to the maximum in order to be used also by not-specialist alike. Future investigation could be conceived to test for the influence of overriding factors that act at global scales. Hopefully, in a next future we could: 1) test the importance of latitudinal gradients and temperature in shaping species distribution; 2) start building long time series, which is one of the research priorities under climate change scenarios.

Acknowledgments: EMCC and Italian Ministry for the Environment and Territory: 'the impacts of biological invasions and climate change on the biodiversity of the Mediterranean sea' Project *.

References
1 - Perry A.L., Low P.J., Ellis J.R. and Reynolds J.D., 2005. Climate change and distribution shifts in marine fishes. *Science*, 308(5730): 1912-1915.
2 - CIESM., 2008. Climate warming and related changes in Mediterranean marine biota. N° 35 In: CIESM *Workshop Monographs*, F. Briand (ed.), 152 pages, Monaco.

* Fondation Prince Albert II de Monaco: "Tropical Signal" Project.

PATTERNS OF PHYTOPLANKTON CHLOROPHYLL VARIABILITY IN THE MEDITERRANEAN AND BLACK SEAS

N. Bahamon [1]*, A. Cruzado [1], Z. Velasquez [2], R. Bernardello [1] and D. Donis [1]
[1] Centre d'Estudis Avançats de Blanes (CSIC) - bahamon@ceab.csic.es
[2] Oceans Catalonia International SL

Abstract

Time series decomposition of remote sensing observations (Aqua-MODIS) of sea surface chlorophyll (SSC) since July 2002 to June 2009 is performed at various coastal and open sea areas in the Mediterranean and Black Seas. The evolution of SSC is assessed against satellite sea surface temperature (SST) and wind vector data provided by ECMWF, in order to disclose possible connections of the environmental variables on the regional chlorophyll trends. The interaction between SSC and the environmental variables is assessed using time-lagged cross-correlations of the variables. Then, the time lags showing the highest significant correlations were chosen for further hypothesis validation using generalized additive models. Results are discussed within the framework of seasonal changes in the Mediterranean area and at global scale.

Keywords: Time Series, Chlorophyll-a, Temperature, Wind/Font

Introduction

Atypical warmer summers and cooler winters have been reported in recent years in the Mediterranean Sea areas. For instance, winter periods in the Gulf of Lions, like those in 1999 and 2005 were atypically cooler and windy, producing submarine cascades with vertical velocity of 80 cm s^{-1} from nominal 10 cm s^{-1}, thus altering benthic organisms and transporting down from surface an atypical large amount of organic matter [1], [2]. We postulate the hypothesis that local unusual seasonal events could leave a signal in upper water layers properties (i.e. not only in the bottom), as they have a direct connection with the atmosphere. Phytoplankton species, with relatively fast growing rates are good indicators of environmental changes. Temperature and wind strength are responsible for changes in surface water density and are potential factors for inducing surface fertilization (increasing phytoplankton primary production) and transporting phytoplankton from surface to deeper water layers altering phytoplankton primary production. The present study deals with sea surface phytoplankton chlorophylls variability in the last seven years (2002-2009) and its relationship with sea surface temperature and wind velocity.

Methods

Twelve locations were selected in the Mediterranean seas and Black Seas for the present study (Fig. 1). Inter-annual trends of 8-day AQUA-MODIS composite SSC and SST, along with 8-day ECMWF composite wind velocity estimated from vectors u and v at 10 above the sea surface, from the week 24 in 2002 up to the week 23 in 2009, were assessed using loess smoothing (non-linear). Then, cross-correlation analyses of chlorophyll time series against SST and wind velocity was performed to investigate for potential real-time and time-lagged connections. Finally, hypothesis validation of potential connections between chlorophylls and the environmental variables was performed using Generalised Additive Models.

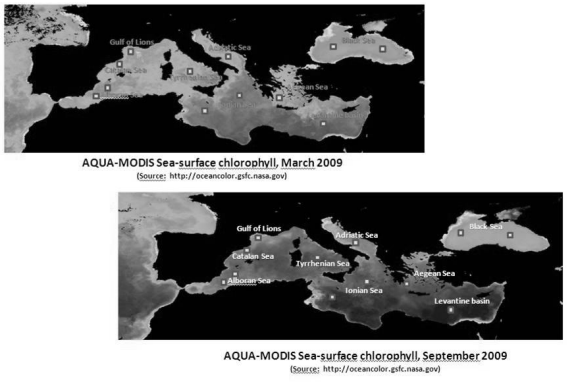


Fig. 1. Monthly composition of Aqua-MODIS sea-surface chlorophylls in the Mediterranean and Black seas(Source:http://oceancolor.gsfc.nasa.gov)

Results

Trends of surface chlorophylls along with temperature and wind velocity are not linear. Chlorophylls in Aegean Sea and Levantine basins show an upward trend of 0.25 mg m^{-3} in last seven years. Seasonal patterns of surface temperature and wind velocity are local, not extending to the whole Mediterranean area, as reported from mesoscale models [3]. Events of highest and lowest values of the variables are generally equivalent to those values observed in the past. Present data do not provide evidence of clear (linear) trends of the variables within last seven years. Just a few local trends seem to be linear, but their linearity is not guaranteed with time. Wind velocity is an environmental factor explaining a minor part of the chlorophyll variability in surface waters in the Mediterranean stations. Most of the chlorophyll variability is generally explained by SST. Relatively strong winds in the Gulf of Lion and Aegean Sea do not affect significantly the surface chlorophyll variability. In the Gulf of Lion, factors other than SST and wind (such as river discharges) are responsible for the variability of surface chlorophylls, whereas in the Aegean Sea, SST is an important factor explaining most (70%) of total phytoplankton variability. In the Levantine basin, SST by itself (i.e. with no covariates in a model) explains the highest variability of surface chlorophyll (81%) compared with the lower variability explained by the models in the remaining 11 stations. The prediction of surface chlorophylls in the Black Sea slightly improves with the addition of wind velocity to SST as explanatory variable. The stations in the Black Sea are the least influenced by SST and winds. The upper water layers of the pelagic ecosystem could not be strongly altered by extreme changes in wind regimes. The pelagic ecosystem was generally sensitive to changes in SST, except in the areas of strong influence of river discharges such as the Gulf of Lions. This leads us to suggest that atypical cool and windy winter seasons in the Gulf of Lions, although altering the deep ocean, do not seem to affect the upper layers of the pelagic ecosystem. Further analysis with data taken in the areas around the deep canyons (where cascading events takes place) in the Gulf of Lions is required to validate the present conclusion.

References

1 - Canals, M., Puig, P. Durrieu de Madron, X., Heussner, S. Palanques, A. and Fabres, J., 2006. Flushing submarine canyons. *Nature* 444: 354-357.

2 - Sardà,F., Company, J.B., Bahamon, N., Rotllant, G., Flexas, M.M., Sánchez, J.D., Zúñiga, D., Coenjaerts, J., Orellana, D., Jordà, G., Puigdefábregas, J., Sánchez-Vidal, A., Calafat, A., Martin, D. and Espino, M., 2009. Relationship between environment and the occurrence of the deep-water rose shrimp *Aristeus antennatus* (Risso, 1816) in the Blanes submarine canyon (NW Mediterranean). *Prog. Oceanog*., 82: 227-238.

3 - Ahumada, M.A. and Cruzado, A., 2007. Modeling of the circulation in the Northwestern Mediterranean Sea with the Princeton Ocean Model. *Ocean Sci*., 3:77–89.

SPATIAL DENSITY AND MORPHOLOGY VARIATION OF *CAULERPA SCALPELLIFORMIS* (BROWN EX TURNER) C. AGARDH (CAULERPACEAE, CHLOROPHYCEAE) IN ANTALYA GULF (TURKEY)

Beylem Banbul acar [1]*, Halil Çolak [1] and Mehmet Gökoglu [1]
[1] Akdeniz University, Faculty of Fisheries - beylemb@akdeniz.edu.tr

Abstract
Morphology and density variations of *C. scalpelliformis* at four locations in the Gulf of Antalya (Levantine Basin) are studied in the period July-September 2009. There were differences in 6 (frond length, number of frond, rhizome length;P<0.05 and apical frond width, pinnule length, diameter of stolons;P<0.01) of 10 morphological characters among the stations. The lowest total stolon length (197 cm/m^2) and density (94,76±0,99 frond/m^2) are observed at the station IV with highest sediment porosity (%44,35).
Keywords: Levantine Basin, Phytobenthos, Density

Introduction
The first record of alien species *Caulerpa scalpelliformis* (Brown ex Turner) C. Agardh from Turkey is reported from Antalya harbour in the period August-September 1995, from depth of 0,5 to 2 meter in seawater with a temperature range of 26.5-27°C. But that species was not found at the same location in the period 1995-1997 because of the low water temperature[1]. Hereafter *C. scalpelliformis* was observed again around the same station at 25.02.99 (low water temperature) from dept of 1-3 meter[2]. This green alga has been cover property as other invasion species and has the rapid spread[2][3]. It may negatively effect biological diversity when didn't take measure[2].

Materials and Methods
Specimens of *C. scalpelliformis* were hand-collected by SCUBA diving in the period July-September 2009 in the Gulf of Antalya from 4 locations (St.I: 36°53'02.78"N,30°42'02.70"E; St.II: 36°52'35.56"N,30°39'56.79"E; St.III: 36°52'11.87"N,30°39'17.98"E; St.IV: 36°51'36.49"N,30°38'21.58"E). The morphological characteristics were measured by using 150 mm 1/100 digital caliper in the laboratory of Faculty of Fisheries. Analysis of variance (ANOVA) and Duncan Multiple Range Test were employed to test the effect of morphological characters and density of *C. scalpelliformis* between the locations. Pearson Correlation Coefficients were measured to indicate the relationship between morphological characters. SPSS version 14.0 was used for all analyses.

Results
The colonies of *C. scalpelliformis* were found at the each station from depth of 15-25 meter in seawater with a temperature range of 28-29°C and salinity of 38.2 psu. The feather-like thallus is delicate with narrow stolons, erect fronds and wide pinnules. The stolons are slender, 0.12-0.17 cm in diameter, with long rhizoids, 4.17-5.91 cm long. The fronds are olive to dark green, 7.26-8.74 cm high and 1.17-1.37 cm broad. Total stolon length (cm), frond number and dry weight (g) of *C . scalpelliformis* in m^2 have higest value (977, 645.79±2.44, 48.3 respectively) on the sandy-slimy sediment with lowest porosity at the Station I (Table I).

Tab. 1. Summary statistics of morphological characters, density of *C. scalpelliformis* and sediment porosity in different locations (means±standard errors) FL:frond length, RL: rachis length, FW: frond width, AFW: apical frond width, PN: number of pinnule, PL: pinnule length, FN: number of frond, SLR: stolon length between two rhizomes, RHL: rhizome length, SD: diameter of stolons

Morphological character		Station I	Station II	Station III	Station IV
FL (cm)		8,21±0,42	8,74±0,39	7,99±0,44	7,26±0,37
RL (cm)		1,08±0,06	1,09±0,09	0,92±0,06	1,12±0,05
FW (cm)		1,37±0,03	1,31±0,01	1,28±0,05	1,17±0,03
AFW (cm)		0,42±0,02	0,69±0,02	0,48±0,04	0,41±0,03
PN (on the one frond)		28,53±1,68	28,13±1,46	28,73±1,55	26,67±1,34
PL (cm)		0,81±0,02	0,82±0,02	0,73±0,05	0,67±0,01
FN (in 10 cm of stolon)		6,61±0,05	8,12±0,04	7,74±0,05	4,81±0,05
SLR (cm)		2,86±0,02	2,02±0,06	2,26±0,03	2,54±0,03
RHL (cm)		5,91±0,47	5,37±0,41	4,17±0,53	4,33±0,39
SD (cm)		0,17±0,08	0,16±0,08	0,14±0,09	0,12±0,05
Porosity of sediment (%)	in	16,09	23,97	21,65	44,35
	out	17,39	21,74	19,36	39,52
Total stolon length (cm) (in 1 m^2)		977	209,51	494	197
Total frond number (in 1 m^2)		645,79±2,44	169,78±0,84	382,36±1,24	94,76±0,99
Dry weight (g) (in 1 m^2)		48,3	17,2	33	8,2

Correlarions between the 12 morphological characters of *C . scalpelliformis* are significant (Table 2).

Tab. 2. Correlation coefficients (Pearson product moment correlation) among the morphological characters on sampled individuals *Caulerpa scalpelliformis* (N=120 and N=40). ** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level, Morphological codes are given in Table I

	FL	RL	FW	AFW	PN	PL
FL	1	0,375(**)	0,395 (**)	0,307(**)	0,864(**)	0,372(**)
RL		1	0,232(*)	0,239(**)	0,104	0,293(**)
FW			1	0,378(**)	0,093	0,721(**)
AFW				1	0,032	0,469(**)
PN					1	-0,011
PL						1

	FN	SLR	RHL	SD
FN	1	-0,26	0,19	0,548(**)
SLR		1	0,41	-0,009
RHL			1	0,051
SD				1

Discussion
C. scalpelliformis is an Indo-Pacific species with a wide distribution in the Indian Ocean and the Pacific as well as on warm-temperate Atlantic coasts[4]. It was found on concrete walls sheltered from waves from depth of 0,5 to 2 meter with stolons 20-21 cm long, 1.2 mm wide, with well-developed rhizoids 1.4 to 4.1 cm long; fronds, up to 5-5.5 cm high and 10-13 mm wide[1]. Our results are greater than these for some morphological characters but correspond to morphological data of *C. taxifolia*[5]. *C. scalpelliformis* was not observed shallower than 15 meter and deeper than 40 m in our study. Despite monthly observations carried out in Antalya harbour as well as in other stations of the Antalya Gulf from October 1995 to June 1997, the species was never detected again. It is indicated that could be due to the low water temperatures occurring in winter at that station which cannot support *C. scalpelliformis*[1]. Recovery of this species at 1999 in winter time at the same station[2] and at 2009 at 4 stations through the Antalya Gulf indicate expantion of the distribution area of *C. scalpelliformis* in the Mediterranean Sea. Our results show that species prefer sandy-muddy bottom to spread.

References
1 - Ertan, Ö.O., Turna, I.I. and Cormaci, M., 1998. A new record for the marine algal flora of Turkey: *Caulerpa scalpelliformis* (Brown ex Turner) C. Agardh (Caluerpaceae, Chlorophyceae). *Tr. J. of Botany*, 22: 285-287.
2 - Aysel, V., Senkardesler, A. and Aysel, F., 2002. Türkiye denizlerine gelen yeni bir tehlikeli alg *Caulerpa scalpelliformis* (R. Brown ex Turner) C. Ag. var. denticulata (Dacaisne) Weber van Bosse (Caulerpaceae, Caulerpales). *E.U. Journal of Fisheries & Aquatic Sciences*, 19(1-2): 105 – 108.
3 - Davis, A.R., Roberts, D.E. and Cummins, S.P., 1997. Rapid invasion of a sponge-dominated deep-reef by *Caulerpa scalpelliformis* (Chlorophyta) in Botany Bay, New South Wales. *Australian Journal of Ecology*. 22: 146-150.
4 - Silva, P.C., Basson, P.W., Moe, R.L., 1996. Catalogue of the Benthic Marine Algae of Indian Ocean. University of California press.
5 - Cevik, C., Yokes M.B., Cavas, L., Erkol, L.I., Derici, O.B. and Verlaque, M., 2007. First report of *Caulerpa taxifolia* (Bryopsidales, Chlorophyta) on the Levantine coast (Turkey, Eastern Mediterranean). *Estuarine, Coastal and Shelf Science.* 74: 549-556.

FIELD IDENTIFICATION GUIDE TO THE LIVING MARINE RESOURCES OF THE EASTERN AND SOUTHERN MEDITERRANEAN

Michel Bariche [1]*, Monica Barone [2], Nicoletta De Angelis [3] and Piero Mannini [4]
[1] American University of Beirut - michel.bariche@aub.edu.lb
[2] Environmental Protection Agency - Tuscany Region (ARPAT)-Via Marradi 114, 57126 Livorno, Italy.
[3] FAO - Fish Finder (Species Identification and Data Programme) - Viale delle Terme di Caracalla 00153 Rome
[4] FAO - Regional Office for the Near East and North Africa, PO Box 2223 Cairo, Egypt

Abstract
The field identification guide surveys marine organisms of commercial and potential commercial importance. The region covered extends from the Mediterranean coast of Turkey proceeding in a general southwestern direction to that of Morocco. Species were selected carefully according to economic interest, commonness and sometimes according to their endangered or invasive status. A total of 372 marine species were considered, including the most common exotic ones. Also presented are their relevant diagnostic features, biological information, and geographical distribution while highlighting their importance on local fisheries. The entire field guide was translated into Arabic for a better accessibility among non scientists in Arabic speaking countries.
Keywords: Fisheries, Alien species, Biogeography, Eastern Mediterranean, Western Mediterranean

Limited knowledge and skills for marine species identification are among the main weaknesses affecting the coastal waters fisheries in the eastern and southeastern Mediterranean countries, namely Turkey, Cyprus, Syria, Lebanon, Egypt, Libya, Tunisia, Algeria, and Morocco. Imprecise species identification hinders accurate estimation of commercial landings and all attempts to develop and manage sustainable fishery measures. The field guide is the first attempt to provide a comprehensive survey of marine species likely to be encountered in fishery landings, on the market and at sea in the covered area. There is a pressing need for such a modern reference work as no similar publication has been presented in over 20 years [1]. Furthermore, the field guide is an original effort to highlight the commercial importance of recent marine introduced species, most of which have well established populations. The field guide is largely based on an extensive list of relevant bibliographic references but also incorporates and organizes a compilation of raw data gathered by nine fishery experts from each of the respective countries.

After a brief introduction of the Mediterranean ecosystem's general features and biodiversity, a section is dedicated to landing statistics reported by all concerned countries since the year 1950. A special emphasis is made on introduced species of commercial importance and on those that are a potential threat to humans, fisheries, and the ecosystem. The marine organisms considered were organized under major taxonomic groups and subgroups. These were crustaceans (stomatopods, shrimps and prawns, lobsters, crabs), molluscs (gastropods, bivalves, cephalopods), echinoderms (sea urchins), and fishes (lampreys, cartilaginous fishes, bony fishes, chimaeras), as well as sea turtles and marine mammals. The most relevant morphological terms and measurements, essential for identification, are described by means of labeled illustrations and a glossary. Each chapter is dedicated to one of the aforementioned taxonomic groups and starts by an introduction summarizing general information such as morphology, biology, as well as the commercial importance concerning this specific group in the Mediterranean. The information given by species contains the valid scientific name as well as the official FAO common names in English, French, and Spanish. In addition, a provisional Arabic common name was recommended. Brief information regarding relevant diagnostic features, biological information and habitat, importance to fisheries and geographical distribution of the species is also included. Conveniently, accurate line drawings for all species complement the information. Particular care was taken to make the field guide user-friendly and accessible to the general public without the need for prior knowledge in marine biology or fisheries. Concurrently, it can be used as a practical working tool for scientists, fisheries professionals, and inspectors reporting landings at the national level, as well as by fishermen, students, sports anglers, and naturalists. It is also expected to serve as a baseline document for environmental assessments and fisheries management. Furthermore, the entire field guide was translated into the Arabic language for a better dissemination among Arabic-speaking users, particularly fishermen. Most commonly used vernacular names in Arabic, Turkish, and Cypriot Greek were also summarized in tables that can be found at the end of the document. An undertaking of this magnitude was done in the hopes of establishing a better form of communication among interested individuals. This "Field Identification Guide to the Living Marine Resources of the Eastern and Southern Mediterranean" was prepared under the coordination of the Fisheries and Aquaculture Management Division, Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations (FAO).

References
1 - Fischer W., Bauchot M.-L. and Schneider M. (eds.), 1987. Fiches FAO d'identification des espèces pour les besoins de la pêche. (Révision 1). Méditerranée et mer Noire. Zone de Pêche 37, FAO, Rome. 1529 p.

COMPARISON OF DISCARDS OBTAINED USING DIFFERENT MESH SIZES AND SHAPES IN THE CODEND OF THE TRAWL

Jorge Baro [1]*, Teresa Garcia [1] and Jose miguel Serna [1]
[1] Instituto Espñaol de Oceanografía. Centro Oceanoghráfico de Málaga - jorgebaro@ma.ieo.es

Abstract
In this work a comparison of the discards rates among trawl gears using different type of codend is presented. Sampling took place during 6 months in 2008 on-board four commercial trawlers in northern Alboran Sea using three different types of meshes in the codend (40-mm diamond- and square-mesh and 50 mm diamond-mesh). Our results showed that discards rates varied between type of meshes but no differences were found between vessels.
Keywords: Alboran Sea, Deep Waters, Fisheries

At a world level between 17.9 and 39.5 million tons of marine organism are discarded [1]. Mediterranean trawl fisheries are highly diverse in terms of species and many of them are discarded for economic (low commercial value) or legal reasons (minimum landing sizes) [2, 3]. Discards are important for stock management because contribute to fishing mortality and they also represent and economic and ecological impact. The use of bigger mesh size than traditional or more selective shapes in the codend can contribute to reduce the discards and hence the impact of fishing in the ecosystem.

Sampling took place between May and October 2008 on-board four selected commercial trawlers representative of the studied area in terms of size, engine power, fishing capacity and construction characteristics. The overall objective of the surveys was to compare profitability of trawl fishing in northeast Alboran Sea between 600 and 800 m depth, using three different types of meshes in the codend (40-mm diamond- and square-mesh and 50 mm diamond-mesh) under commercial condition. The weights of landed and discarded organism were estimated by on-board observers for 451 trawl daylight hauls following commercial fishing procedures. The average duration of the trawls was 3.5 hours. All species captured were weighted and counted. Two-way analysis of the variance, (ANOVA) was used to test differences in the pattern of the yields (kg/hauls) between fishing vessels and type of meshes.

Discarded rates ranged from 4.4% and 16% of the total catch depending on the vessels and the type of codend. Fishes were the most important group in terms of weight discarded for all the vessels (41.7%-65.9% of the total), followed by crustaceans (11.8%-23.11) and molluscs (8.5%-11.16%) (Table 1). Main discarded fishes were Condricthyans and Macroruidae: *Nezumia aequalis, Chimaera monstrosa, Torpedo nobiliana, Etmopterus spinax, Dalatias licha, Trachyrhynchus trachyrhynchus, Galeus melastomus* and *G. atlanticus.* The crustaceans *Dardanus arrosor*, other Paguridae and *Polycheles typhlops* and the molluscs *Octopus defilippi Neorossia caroli, Eledone cirrhosa* and *Pteroctopus tetracirrhus* were the main species discarded in these two groups.

Tab. 1. Discards (g/haul) by group of species and type of meshes in the codend (40SQ: 40 mm square-mesh; 50D: 50 mm diamond m-mesh; 40D 40 mm diamond mesh)

	Fishes	Crustaceans	Molluscs	Echinoderms
40C	16883	87	135	103
50R	19420	124	164	106
40R	10940	124	231	98

;

Discards rates were significant different between type of meshes of the codend ($p<0.05$), although there were not observed differences between the discards between vessels. In general highest rates of discards were recorded for the 50 mm diamond-mesh codend (Table 2)

Tab. 2. Discarded rates (in percentages) by vessels and type of meshes in the codend (40SQ: 40 mm square-mesh; 50D: 50 mm diamond m-mesh; 40D 40 mm diamond mesh)

	40C	50R	40R
Vessel 1	10,78	15,30	8,70
Vessel 2	10,57	16,24	4,44
Vessel 3	10,20	8,62	5,60
Vessel 4	12,78	11,36	4,37

.

References
1 - Alverson D.L., Freeberg M.H., Muraski S.S., Pope J.G. A global assessment of fisheries bycatch and discards. *FAO Fish. Tech. Pap.*, 339: 233.

2 - Machias A., Vassilopoulou V., Vatsos D., Bekas P., Kallianiotis A., Papaconstantinou C., Tsimenides N., 2001. Bottom trawl discards in the northeastern Mediterranean Sea. *Fisheries Research*, 53: 181-195.

3 - Carbonell A., Martin P., de Ranieri S., WEDIS team. Discards of the Western Mediterranean trawl fleets. *Rapp. Comm. Int. Mer Médit.* 35:312-393.

INFLUENCE OF FOOD AVAILABILITY AND COASTAL CIRCULATION IN THE SPAWNING STRATEGIES OF FISH SPECIES OF CABRERA NATIONAL PARK (NW MEDITERRANEAN).

G. Basterretxea [1]*, A. Jordi [1], A. Sabatés [2], I. Alvarez [1], I. Catalán [1], M. Palmer [1] and B. Morales-nin [1]
[1] IMEDEA (UIB-CSIC) - vieagbo@uib.es
[2] ICM (CSIC)

Abstract
Temporal variation of fish larvae during the winter-summer transition in Cabrera National Park (SE Mallorca) reveal two spawning strategies of coastal species; (1) a few species spawn early in the year coupled with the zooplankton biomass peak (e.g. *Diplodus sargus, Boops boops*), and (2) a larger proportion of species spawn in early summer when hydrographic conditions are milder but food availability is lower (e.g. *Coris julis, Serranus hepatus*). Specific abundances in spring were fairly higher than in summer (~7 fold). We interpret these strategies on the basis of food availability and change in coastal circulation.
Keywords: Ichthyoplankton, Circulation, Fishes

Introduction
Discerning the environmental factors that are relevant in each coastal area for the survival of early life stages and, particularly, the identification of critical zones and periods for the resource development is essential for the management of marine protected areas (MPAs). Among the physical and biological signals affecting ichthyoplankton assemblages, seasonality is one of the most notable forcings. Yet, there is no unique adaptative response of fish larvae to seasonal changes. Conversely, in order to optimize the reproductive success, larval timing may strongly differ among species. A combination of favorable hydrodynamic conditions, food availability and quality, and predation avoidance, among other factors, may determine the spawning period, particularly in temperate seas such as the Mediterranean Sea with a marked seasonal cycle in temperature.

Archipielago de Cabrera National Park is a marine protected area situated to the south of Mallorca (Balearic Islands). As in other oligotrophic areas, food availability is low and increases in zooplankton biomass generally restrict to a late winter bloom. A major aspect of the circulation around the Mallorcan shelf is the presence of island trapped waves (ITWs) generated by local wind forcing [1]. Transport is thus conditioned by prevailing meteorological conditions. Retention mechanisms near the adult habitat together with food availability are postulated as major constrains to fish larvae survival. This study seeks to identify the consequences of spawning timing of coastal fish species in the waters of Cabrera National Park in the context of these two factors.

Materials and methods
Sampling consisted on fortnightly measurements at three stations located between Mallorca and Cabrera that were visited between February and August 2007. These measurements where complemented with current records from a bottom mounted ADCP. Zooplankton samples were collected with vertical tows of a WP2 net and fish larvae were sampled by oblique hauls of a bongo net (0.6 m mouth opening). Wind maps were constructed by optimal interpolation from wind data recorded by two coastal stations and Quikscat satellite data for the period (2000-2009). Synoptic wind patterns were identified using the Self-Organizing Map (SOM) algorithm. To compute a range of likely larval transport outcomes, an individual based model (IBM) for larval dispersal was developed using velocity fields of a high-resolution (~200 m) ocean circulation model (POM). Simulations were run for 30 days forced by the computed wind patterns to simulate the generation and propagation of ITWs.

Results and discussion
Fish larvae belonging to a total of 57 taxa were identified. Larval mean abundances fluctuated between 25 and 162 ind m^2 which is in the range of average values in Mallorca [2]. Attending adult habitat, fish larvae were grouped into two groups: i) larvae of shorefish and shelf dwelling species and ii) larvae of mesopelagic species, dwelling in the open sea. The species included in the latest group, the majority of them belonging to Myctophidae family, were more abundant in summer, but their presencewas episodic and presumably associated to oceanic water intrusion in the continental shelf. Concerning the species included in the first group, a clear temporal variability in the ichthyoplankton composition was observed between spring and summer, with an increase in the number of taxa in summer. Some species, such as *Diplodus sargus* and *Boops boops* were particularly abundant in spring and showed the highest abundances in April, following the seasonal peak of zooplankton. Other species, such as *Serranus hepatus* or *Coris julis*, peaked in summer though, in general, their abundances were lower than that of the spring species. The onset of the spawning period for these species occurred in early June when water temperatures raised above 20ºC.

Wind patterns from SOM classification reveal a seasonal wind regime characterized by two typical wind modes. Eastern winds are prevalent on summer (Jun.-Aug.) whereas alternation between easterly and westerly episodes occurs in spring (Mar.-May). These changes in wind forcing have consequences in mean coastal transport that reveal a shift in current direction at the beginning of early summer. Numerical simulations of wind forced ITWs capture well the main features of measured current variability suggesting that coastal circulation responds energetically to this local forcing and that shelf currents are relatively uncoupled from oceanic flows. This is also evidenced by the scarce and episodic presence of oceanic fish larvae. Larval trajectories computed with the IBM model reveal the differences in the dispersion patterns attending to wind forcing. ITWs generated by the westerly winds tend to disperse larval particles toward the outer shelf, whereas the eastward winds (prevailing in summer) retain larval particles in the north-western coast of Cabrera. This suggests that while increased food availability may be advantageous for the development of spring species, larvae would be more susceptible to be advected far from the adult habitat. However, loss by dispersion could be partially compensated by a higher abundance of larvae in the plankton during that period. On the other hand, summer spawning would guarantee larval fish retention in the coastal environment. This last strategy would be advantageous for the maintenance of fish populations in the area, what is especially relevant in the context of the MPAs.

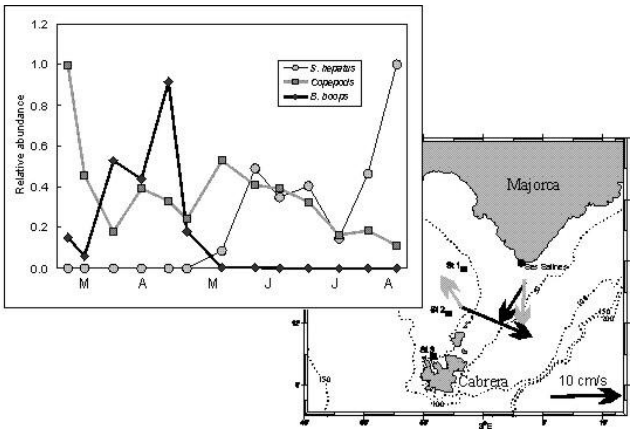


Fig. 1. Map showing the three sampled stations and mean summer (gray) and spring currents (black) currents. Inset: relative abundances of copepods and a spring (*B. boops*) and summer (*S. hepatus*) species

References
1 - Jordi A., Basterretxea G. and Wang D.-P., 2009. Evidence of sediment resuspension by island trapped waves. *Geophys. Res. Lett.*, 36: L18610, doi: 10.1029/2009GL040055. -

2 - Alemany F., Deudero S., Morales-Nin B., López-Jurado J.L., Jansà J., Palmer M. and Palomera I., 2006. Influence of physical environmental factors on the composition and horizontal distribution of summer larval fish assemblages off Mallorca Island (Balearic archipelago, western Mediterranean). *J. Plank. Res.*, 28: 473-487.

AGEING WITH ALCIAN BLUE DUYING TECHNIQUES FOR SOME ELASMOBRANCHS IN ISKENDERUN BAY, EASTERN MEDITERRANEAN

Nuri Basusta [1], Sefa ayhan Demirhan [2], Asiye Basusta [1]* and Erdogan Cicek [3]
[1] Firat University, Fisheries Faculty, Elazig,Turkey - agirgin@firat.edu.tr
[2] Mustafa Kemal University, Fisheries Faculty, Iskenderun Hatay, Turkey
[3] Nevsehir University, Department of Biology, Nevsehir, Turkey

Abstract
In this study, the vertebrae of the common eagle ray (*Myliobatis aquila*) and backchin guitarfish (*Rhinobatos cemiculus*) were used for ageing. A total of 10 *M.aquila* (females and males) and 10 *R. cemiculus* (females and males) were sampled. Age determinations were carried out using vertebral sections. Alcian blue dying techniques were used to enhance the visibility of the band on vertebrae.
Keywords: Biodiversity, Eastern Mediterranean, Elasmobranchii

Introduction
Chondrichthyan fish are of low productivity compared to teleost fishes. Because of low productivity, target or non-target chondrichthyan species are most affected by commercial fisheries. For this reason, most of elasmobranches are listed in IUCN Red Data Book. Impact of commercial fisheries on chondrichthyan fish population around the world is currently the focus of considerable international concern of both academicals or non-governmental organizations for conservations and management of stocks. One of the most important points in fish and fisheries biology is age determination. Particularly if it is necessary to determine fish population structure, age determination has crucial importance. Bone of chondrichthyan species has not calcium, therefore their age determination is not easy relative to teleost fishes. For this reason, chondrichthyan stocks management strategies become harder. Age determination in chondrichthyan species can be done using some staining techniques which can make growth bands visible. Different staining techniques have been using to make growth bands visible. However success of the age determination varies for each technique. Numerous techniques have been used in the attempts to enhance the visibility of growth bands in vertebrae of elasmobranchs. All of these techniques show that the success of each technique is often species specific and that slight modifications in the technique may enhance the results. Alcian blue staining technique have used to enhance the visibility of the cartilage skeleton of mouse embryos and cartilage and related tissues in the trunk and fins of teleosts. However, the techniques have used to first time on elasmobranchs vertebrae successfully [1].

Material and Methods
This study was conducted on the north-eastern Mediterranean coast of Turkey). Samples were collected by using commercial gill-net (44 mm mesh size), trawling (44 mm stretch length) and longline fishery. In this study A total of 10 *M. aquila* (females and males) and 10 *R. cemiculus* (females and males) were sampled. Age determinations were carried out using vertebral sections. Eight to ten vertebrae were removed from the widest portion of the body, just behind the gill slits for each specimen. Remaining muscle tissue was removed from each centrum using a knife and to remove excess connective tissue, the centra were soaked in 5% sodium hydrochloride for one day and then rinsed in distilled water. The vertebrae were preserved in 70% ethanol until the examination. The diameter of examined vertebrae was measured to the nearest 0.01 mm for each sample, using a manual caliper. The sections were mounted on microcope slides using transparent acrylic glue and were polished with sandpaper until approximately 0.5 mm in thickness. In this study alcian blue dying techniques were used to enhance the visibility of the band on vertebrae. The section was soaked in alcian blue solution (16 ml 100% ethanol, 2 mg alcian blue and 4 ml glacial acetic acid in 0.8 ml distilled water) for 12 h. In order to determine the age (A), the sections were viewed in a stereo microscope (X10 magnification) with both transmitted and reflected light for identification of growth rings. Images of the vertebrae were captured with a digital camera (Kodak, 6.0 MP) and the images were examined using PhotoshopTM 7.0.

Results and Discussion
Alcian blue dying techniques were used to enhance the visibility of the band on vertebrae and were stained and age bands on the vertebrae (Fig.1) were observed to be quite visible.

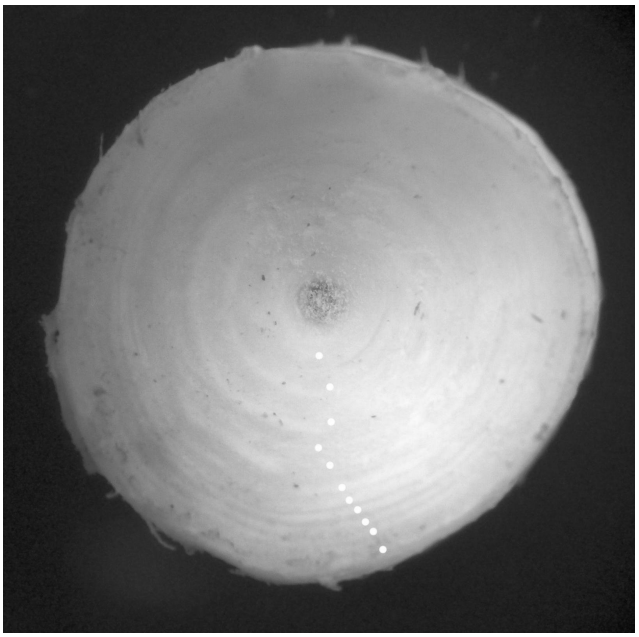


Fig. 1. Age marks on the vertebrae for *Rhinobatos cemiculus*

Rhinobatos rhinobatos percentage of readable vertebrae was 84% [1] , for this study they were 90%. Thus it can be claimed the alcian blue staining technique can be used successfully for the age detemination of elasmobranchs vertebrae [2].

References
1 - Basusta, N., Demirhan, S.A., Çiçek, E., Basusta, A., Kuleli, T., Age and growth of the common guitarfish, Rhinobatos rhinobatos (Linnaeus, 1758), in Iskenderun Bay (northeastern Mediterranean, Turkey). Journal of Marine Biological Association of the United Kingdom (2008). 88 (4) 837-842.
2 -
Basusta,N.,Demirhan,S.A.,Çiçek,E.,Basusta,A.,2008.Alcian Blue Staining Technique for Age Determination of Chondrichthyan Fish. JMBA Global Marine Environment.18.

FISH FAUNA OF THE MARKIZ ISLAND (ÇANDARLI BAY, AEGEAN SEA)

Bahar Bayhan [1]*, Murat Kaya [1] and Tuncay Murat Sever [1]
[1] Ege University, Faculty of Fisheries, Department of Hydrobiology - bahar.bayhan@ege.edu.tr

Abstract
In order to establish benthic and pelagic marine fish in the vicinity of Markiz Island, compherensive submarine observations were conducted by diving with and without scubas. Beside that a 30 minute trawl hauling was made to collect benthic species in north east of the island, with 70 fish species of 25 family being determined.
Keywords: Aegean Sea, Fishes, Teleostei

Introduction
Northern part of Aegean Sea is under the influence of cool and less saline currents from Black Sea while the southern part is influenced by warm and salty currents. The study area is geographical transition between both seas. The differences observed in ecological features of Aegean Sea were suited to this geographical properties. It is possible to describe its middle section as a transitive zone, therefore there is a rich biological diversity in Aegean Sea where more than 300 fish species and some 5000 invertabrate were reported [1]. Recent lists have included new records a total of 389 marine fish, which indicates that Aegean Sea ranks on the top of the list of species among Marmara, Mediterranean and Black Seas coasts of Turkey [2]. Papaconstantinous [3] however reports that 447 marine species inhabit Greece Seas. This study aims to establish fish species in the vicinity of Markiz Island.

Material and Methods
In order to establish benthic and pelagic marine fish in the vicinity of Markiz Island, located in the enterence of Çandarli Bay in Aegean coast of Turkey, submarine observations were conducted by diving with and without scubas in 2007. Beside that a 30 minute trawl hauling was carried on to collect benthic species in north east of the island, with fish collected being asssessed in two categories, namely benthic and pelagic. Taxanomic categories used for fish considered [4], [5] and [6].

Results and Discussion
70 fish species of 25 family were determined and collected fish being asssessed in two categories, namely benthic and pelagic. Table 1 includes pelagic species and Table 2 shows demersal species. Sparidae family was the highest in number, followed by Labridae with 10 and Mugilidae with 5 species. These fish species were well known fish fauna in the Mediterranean Sea [2].

Tab. 1. Pelagic fish fauna of Markiz Island

FAMILIA	SPECIES
Clupeidae	*Sardina pilchardus*
Engraulidae	*Engraulis encrasicolus*
Belonidae	*Belone belone*
Pomatomidae	*Pomatomus saltator*
Carangidae	*Trachurus trachurus*
	Trachurus mediterraneus
	Lichia amia
	Seriola dumerilii
Sparidae	*Boops boops*
Scombridae	*Scomber japonicus*
	Scomber scombrus
	Thunnus thynnus
Sphyraenidae	*Sphyraena sphyraena*
Mugilidae	*Chelon labrosus*
	Mugil cephalus
	Liza aurata
	Liza ramada
	Liza saliens
Atherinidae	*Atherina boyeri*
	Atherina hepsetus

Tab. 2. Demersal fish fauna of Markiz Island

FAMILIA	SPECIES	FAMILIA	SPECIES
Congridae	*Conger conger*	**Labridae**	*Labrus bergylta*
Syngnathidae	*Syngnathus acus*		*Labrus merula*
	Nerophis ophidion		*Symphodus cinereus*
Serranidae	*Serranus cabrilla*		*Symphodus ocellatus*
	Serranus hepatus		*Symphodus roissali*
	Serranus scriba		*Symphodus rostratus*
Moronidae	*Dicentrarchus labrax*		*Symphodus tinca*
Sciaenidae	*Sciaena umbra*		*Symphodus mediterraneus*
Mullidae	*Mullus barbatus*		*Coris julis*
	Mullus surmuletus		*Thalassoma pavo*
Sparidae	*Dentex dentex*	**Gobiidae**	*Gobius bucchichi*
	Diplodus annularis		*Gobius cobitis*
	Diplodus puntazzo		*Gobius niger*
	Diplodus sargus		*Gobius cruentatus*
	Diplodus vulgaris	**Blenniidae**	*Lipophrys pavo*
	Lithognathus mormyrus		*Parablennius gattorugine*
	Oblada melanura		*Parablennius tentacularis*
	Pagellus acarne		*Blennius sanguinolentus*
	Pagellus erythrinus	**Trachinidae**	*Trachinus araneus*
	Pagellus centrodontus	**Uranoscopidae**	*Uranoscopus scaber*
	Sarpa salpa	**Scorpaenidae**	*Scorpaena scrofa*
	Sparus aurata		*Scorpaena porcus*
	Spondyliosoma cantharus	**Triglidae**	*Trigla lucerna*
Centracanthidae	*Spicara maena*	**Soleidae**	*Solea solea*
	Spicara smaris		*Solea ocellata*

References
1 - Kocatas,A., Bilecik,N., 1992. Aegean Sea and Its Living Resources. *Publications of Research Institute of Bodrum*, 88 pp.
2 - Bilecenoglu M., Taskavak E., Mater S. and M. Kaya., 2002. Checklist of the marine fishes of Turkey. *Zootaxa*, 113: 194 pp.
3 - Papaconstantinou, C., 1988. Check-list of marine fishes of Greece. FAUNA GRAECIAE IV. National Center for Marine Research, Hellenic Zoological Society, Athens.
4 - Hureau, J.C. and Monod, Th., 1973. Check-list of the fishes of the north-eastern Atlantic and of the Mediterranean (*Clofnam*), Paris, 683 pp.
5 - Whitehead, P.J.P., Bauchot, M.L., Hureau, J.C., Nilsen, J. and Tortonese, E., 1984, 1986a, 1986b. Fishes of the North-eastern Atlantic and the Mediterranean,Vol. I: 1-510 (1984); Vol. II: 515-1007 (1986a); Vol. III: 1015-1473 (1986b).
6 - Bauchot, M.L., 1987. Poissons osseux.in: W.Fisher, M.L. Bauchot et M. Schneider (Réd.)., Fiches FAO d'identitification des espéces pour les besoins de la peche (Revision1), Méditerranéee et Mer Noire. Zone de peche 37, Vol.2: Vertebres, 1529 pp.

PRESENT STRUCTURE AND DISTRIBUTION OF MACROBENTHIC POPULATIONS IN THE NORTH - WESTERN BLACK SEA – ROMANIAN SHELF

Tatiana Begun [1], Adrian Teaca [1], Marian Traian Gomoiu [1] and Mihaela Muresan [1]*
[1] National Institute of Marine Geology and Geoecology – GeoEcoMar, Constanta Branch - mmuresan@geoecomar.ro

Abstract
The distribution of soft bottom macrobenthic populations was studied by analyzing 325 quantitative samples in the Romanian Black Sea continental shelf. A total of 240 taxa belonging to 25 systematic groups were found in the assemblages, within Polychaeta had the highest number of species and individuals. The maximum biodiversity occurred in the mud mussels and *Modiolus* biocoenosis, whereas the highest abundances in the shallow waters.
Keywords: Zoobenthos, Continental Shelf, Black Sea

Introduction
In the last decades the Black Sea has suffered major changes induced by human activities. Many species disappeared or decreased in biomass, e.g. the mussel *Lentidium mediterraneum, Donacilla cornea, Mytilus galloprovincialis* [1]. Other species increased explosively in biomass, e.g. the bivalve *Mya arenaria*, the polychaet *Melinna palmata.* It is assumed that these modifications of the ecosystem were essentially caused by changes in nutrient discharges through major rivers, particularly the Danube [1]. This study, based on the results of researches performed in the past 7 years, comes to complete some gaps in the specialty literature concerning spatial distribution of macrobenthic populations of the Romanian Black Sea Shelf.

Materials and methods
In the period 2003 - 2008, a number of 325 quantitative benthos samples were collected at depths ranging between 0 – 213 m by means of the van Veen-type grab, box corer and multicorer. The offshore samples were collected during several cruises (R/V „Akademik" 2003 and 2006, R/V „Parshin" 2005, R/V „Mare Nigrum" 2006, 2007 and 2008), while the inshore samples during several national projects covering only the sedimentary substrata. The sampling was done with 0.1 m^{-2} van Veen grab, 0.25m^{-2} box corer, 0.015 m^{-2} multicorer.

Results and Discussion
The analyses of the samples helped identify 240 taxa (235 species) of which Spongia - 9, Coelenterata – 16, Turbellaria – 3, Nemertini – 6, Polychaeta – 77, Oligochaeta -1, Hirudinea – 1, Mollusca – 48, Bryozoa -1, Sipunculida – 1, Phoronida – 1, Pantopoda -2, Crustacea – 58, Echinodermata – 3, Tunicata - 6 and indeterminated taxa - 7, approximately 70% of the total number of species recorded in period 1960-1970 [2]. The mean abundance of the macrobenthic populations was 11,914.9 ind.m^{-2} for density and 573.4 g.m^{-2} for biomass.
Most macrobenthic taxa occurred in the samples had a small frequency; out of the 240 taxa recorded, 137 taxa had a frequency of 1-2 %, 34 taxa 2-5 %, 23 taxa 5-10 %, 27 taxa 10-20 %, 17 taxa 20-50 % and only two species had a frequency over 50 % (polychaet *Capitella capitata* andamphipod *Ampelisca sarsi*).
Numerical abundances were dominated by worms (6,974.4 ind.m^{-2}) and molluscs (3,689.8 ind.m^{-2}) populations representing 89 % of the total mean density of benthos. As weight, only the molluscs (*Mya arenaria, Mytilus galloprovincialis*) represented more than 66% of the total mean biomass.
The distribution species is conditioned by the input of fresh water from the Danube. The influence of Danube plume extend on the coast between front of Delta and Midia Cape where the number of macrobenthic species is very small, dominated by the opportunistic euryhaline species resistant in conditions of accentuated sedimentation, as: *M. arenaria, A. sarsi, Alitta succinea*.
The maximum number of species occurred at a mud mussels biocoenosis (21 – 50 m: 159 taxa) and *Modiolus* biocoenosis (51 – 110 m: 153 taxa), whereas the lowest number was found between 111 – 150 m depth (16 taxa) (Fig. 1).
The numerical and biomass abundance of macrobenthos populations diminishes from the shallow waters to the periazoic level (Fig. 2). The curves describing the distribution tendency of the density and biomass according to the bathymetric gradient is a logarithmic type function with a high correlation coefficient (R^2 = 0.93 for density, R^2 = 0.85 for biomass). The distribution of macrobenthos fauna on the Romanian shelf is limited by the drastic decrease of oxygen and the increase of H_2S at approximately 150 -170 m depth.

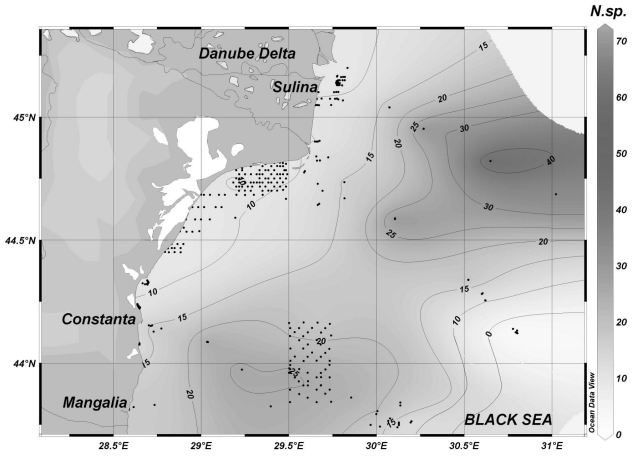


Fig. 1. The number of species of macrobenthic populations' distribution on the Romanian Black Sea Shelf

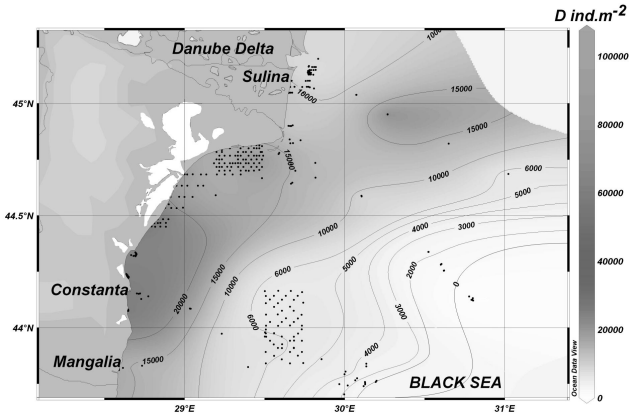


Fig. 2. The numerical abundance of macrobenthic populations' distribution on the Romanian Black Sea Shelf

Acknowledgements: The authors thank to Dr. Gabriela Paraschiv and to Dr. Victor Surugiu for their help in identifying the polychaeta species.

References
1 - Gomoiu, M.-T., 1992. Marine eutrophication syndrome in the north-western part of the Black Sea. Science of the Total Environment. Suppl., Elsevier Science Publishers B.v., Amsterdam: 683-692.
2 - Bacescu, M., Müller, G. I., Gomoiu, M.-T., 1971. Researches of benthic ecology in the Black Sea. Quantitative, qualitative and comparative analyses of the Pontic benthal fauna. *Ecologie marina*, 4, Ed. Academia Romana, Bucharest, pp 357

DYNAMIQUE SPATIOTEMPORELLE DES POPULATIONS D'INVERTEBRES VAGILES ASSOCIEES A L'HERBIER POSIDONIE SUR LA COTE NORD-EST DE LA TUNISIE

Walid Belgacem [1]*, Habib Langar [2] and Oum Kalthoum Ben Hassine [1]
[1] Faculté des Sciences de Tunis, Manar I, 1092, Tunisie - walidbelgacem@yahoo.fr
[2] Institut National des Sciences et Technologies de le Mer, 2025 Salammbô, Tunisie

Abstract
Dans ce travail, 109 espèces vagiles ont été échantillonnées et identifiées. Elles appartiennent à 6 groupes dont les Crustacés, les Mollusques ; les Polychètes sont les plus dominants. Les assemblages faunistiques ont varié en fonction du temps et surtout de la profondeur et des paramètres phénologiques de l'herbier. Le recours à différentes méthodes d'analyse, nous a permis de confirmer l'impact prépondérant de la profondeur et de certains paramètres phénologiques de l'herbier sur la diversité et les assemblages des macroinvertébrés de l'herbier de posidonie.
Keywords: Phanerogams, Biodiversity

Sur les côtes tunisiennes, les travaux qui se sont intéressés à l'étude des macroinvertébrés associés à l'herbier de posidonie sont relativement rares. Cela nous a incité à entreprendre ce travail dont les principaux objectifs sont la connaissance des populations de macroinvertébrés vagile associés à *Posidonia oceanica* et les variations spatiotemporelles de leur diversité et de leurs assemblages. Pour cela, nous avons choisi comme site d'étude la région de Cap Zebib, situé au Nord-est de la Tunisie. Dans cette zone, les prospections ont été réalisées durant la période allant de mai à décembre 2007. L'échantillonnage a été effectué à l'aide d'un cylindre de 25 cm de diamètre [1] au niveau de deux stations localisées respectivement à 3 et à 12 m de profondeur. L'ensemble des échantillons collectés nous ont permis d'identifier 109 espèces d'invertébrés appartenant à 6 groupes : les Crustacés (42), les Mollusques (39), les Polychètes (19), les Echinodermes (6), les Sipunculidés (2) et les Némertiens (1).

La richesse spécifique a toujours été plus élevée à la profondeur de 3m qu'à celle de 12m. L'indice de Shannon Wienner (log e) a varié de 2,2 à 3,53 bits avec une valeur plus importante à 3m.

La classification hiérarchique nous a permis de distinguer deux groupes (A et B). Ces groupes représentent les échantillons récoltés respectivement à 3 et à 12 m de profondeur (Fig. 1a). L'analyse de chaque groupe, pris séparément, a révélé une large similarité entre le cluster des Crustacés et celui de l'ensemble de la macrofaune, ce qui traduit la dominance de ce groupe (Fig. 1b). Cette variation spatiale des populations a été confirmée par l'ANOSIM qui a permis d'obtenir une valeur globale de R significative pour le facteur profondeur ($r = 0.338$; $p < 5$ %).

Pour établir les relations entre la faune associée, la profondeur et les paramètres phénologiques de l'herbier, le test de Spearman a été appliqué pour les trois groupes dominants. Ainsi, pour les Mollusques, une corrélation négative a été observée entre la profondeur, d'une part et la richesse spécifique, le nombre d'individus et l'indice de Shannon Wienner, d'autre part. Pour le groupe des Polychètes, le nombre d'espèces et H' sont corrélés positivement avec la densité et la profondeur. Enfin pour les Crustacés, une corrélation négative a été observée entre le nombre d'individus et la surface foliaire. La structure des peuplements d'invertébrés associés à *Posidonia oceanica* est donc plus influencée par les variations spatiales que temporelles. L'ensemble des observations sont en concordance avec les résultats obtenus dans d'autres secteurs de la Méditerranée [2], [3].

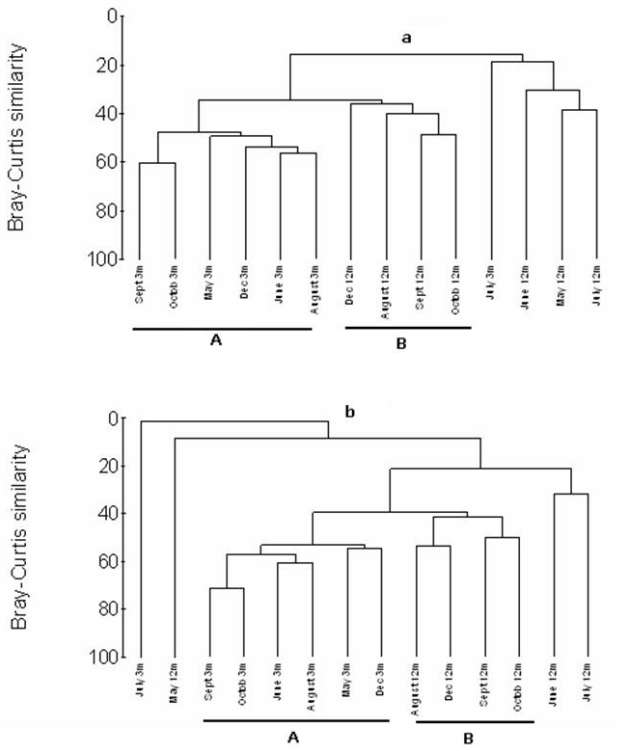


Fig. 1. Dendrogramme de similarité de Bray-Curtis représentant toute la faune (a) et le groupe des Crustacés (b).

References

1 - Borg J.A., Attrill M.J., Rowden A.A., Schembri P.J. and Jones M.B., 2002. A quantitative technique for sampling motile macroinvertebrates in beds of the seagrass *Posidonia oceanica* (L.) Delile. *Scientia Marina*, 66 (1): 53-58.

2 - Buia M. C., Mazzella L., Gambi M. C., Brandini E., Lorenti M., Procaccini G., Scipione M.B., Terlizzi A. and Zupo, V., 1999. Preliminary Data on Epiphytic Flora and Vagile Fauna of the *Posidonia oceanica* Beds at the Marine Reserve of Ustica Island (Sicily). *Biologia Marina Mediterranea*, 6 (1): 240-242.

3 - Scipione M.B., Gambi M.C., Lorenti M., Russo G.F. and Zupo V., 1996. Vagile Fauna of the Leaf Stratum of *Posidonia oceanica* and *Cymodocea nodosa* in the Mediterranean Sea. Seagrass Biology: Proceeding of an International Workshop, pp. 249-260.

IMPACT D UNE POLLUTION THERMIQUE SUR UN ECOSYSTEME COTIER A L EST DE LA TUNISIE

Meher Bellakhal [1]*, Mouna Bellakhal Fartouna [1], Ons Kéfi Dali-Yahia [2] and Mohamed Néjib Dali Yahia [2]
[1] Unité de recherche Exploitation des Milieux Aquatiques, Bizerte, Tunisie - meher2976@yahoo.fr
[2] Unité de Recherche Ecosystèmes et Ressources Aquatiques, GRPH-INAT, 1082 Tunis

Abstract
L'écosystème côtier de la baie de Sousse a révélé l'existence de variations spatiales importantes influencées par la pollution thermique provenant de la centrale électrique de la région. La valeur moyenne estivale de la température est normalement de l'ordre de 27°C. Cependant, elle a atteint 36°C au niveau du rejet durant la période d'étude. Les densités cellulaires du phytoplancton ont atteint 1 306 050 cellules/l au niveau du rejet contre 13 710 cellules/l au niveau des stations les plus éloignées.
Keywords: Phytoplankton, Thermal Pollution, Eutrophication

Introduction
Les effluents urbains et industriels sont, la plupart du temps, les acteurs majeurs du déséquilibre écologique au niveau des écosystèmes côtiers [1]. Les rejets d'eau chaude à partir des centrales électriques sont aussi d'une importance non négligeable [2], [3], [4] et [5]. C'est dans ce contexte que la baie de Sousse, située sur la côte Est de la Tunisie (35°50' N ; 10°50' W) a été exposée, au cours de ces dernières décennies, à plusieurs problèmes d'ordre environnementaux. En effet, une prolifération massive inhabituelle de méduses est devenue incontestablement le rendez-vous des baigneurs chaque été. La pollution thermique, provoquée par la centrale électrique, qui déverse de l'eau chaude dans ce milieu par l'Oued Hamdoun, pourrait être à l'origine de cette prolifération via le réseau trophique. Cette étude démontre l'influence de cette pollution thermique sur la répartition spatiale de la population phytoplanctonique au niveau de cet écosystème côtier.

Matériel et méthodes
Les stations d'échantillonnage sont réparties sur 5 radiales séparées l'une de l'autre de 2 Km et dont chacune comprend 3 stations selon les isobathes : 2 m, 5 m et 10 m. De plus, 2 stations ont été choisies à proximité des canaux d'amené d'eau de mer pour la centrale électrique, 2 autres au niveau du rejet et une station de référence en amont du site selon le sens du courant, ont également été choisies. L'identification et le dénombrement du phytoplancton ont été effectués selon la méthode d'Utermöhl. Seules les espèces appartenant aux Dinoflagellés et aux Diatomées ont été prises en considération dans cette étude.

Résultats et discussion
La température de l'eau a oscillé, durant la période d'étude, entre une valeur minimale de 26°C au niveau de la station la plus éloignée du rejet et une valeur maximale de 36°C au niveau de la station la plus proche. Des valeurs de température assez élevées, de 32°C, ont été également enregistrées au niveau des stations de la 1re et 2e radiale, qui sont très proches de l'effluent. Au niveau des stations de la 3e, 4e et 5e radiales, la température n'a pas dépassé 27 °C. Le regroupement des stations d'échantillonnage en fonction de la température de l'eau (Fig.1), met en évidence trois groupes de stations selon leurs affinités thermales. Le premier groupe comprend les stations OH1 et OH2 qui sont les plus proches du rejet. Le deuxième groupe comprend les stations 12 et 22 qui sont sous l'influence directe du rejet. Enfin, le troisième groupe comprend le reste des stations qui sont relativement à l'abri de la pollution thermique. Les densités cellulaires du phytoplancton les plus élevées (1 250 000 cellules/l) ont été enregistrées au niveau des stations les plus proches de l'effluent. Les stations situées au niveau de la première et la deuxième radiale, présentent, elles aussi, des concentrations phytoplanctoniques relativement très importantes. Le regroupement des stations en fonction des densités phytoplanctoniques sur la base de la distance euclidienne, montre également trois groupes de stations à densités phytoplanctoniques comparables. Les trois stations les plus proches du rejet appartiennent au même groupe présentant les densités phytoplanctoniques les plus élevées. Ce qui révèle encore une fois l'influence directe de ce rejet sur l'accroissement de la production primaire au niveau de cette zone. Néanmoins, cette influence n'est pas de très grande ampleur et elle s'exerce sur une superficie de l'ordre de quelques Km^2. Ainsi, l'effet de cette pollution thermique semble s'estomper à partir de la troisième radiale située à environ 6 Km du rejet. En revanche, la prolifération du phytoplancton semble être influencée par l'action conjuguée de la température et de la richesse en éléments nutritifs comme cela a été constaté au niveau de quelques écosystèmes comparables [6].

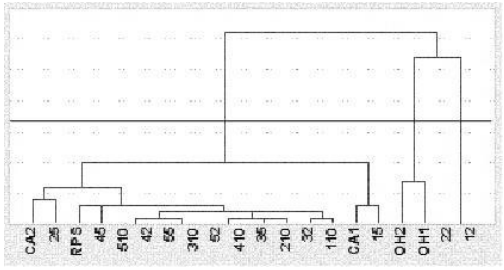


Fig. 1. Regroupement des stations selon la température de l'eau sur la base de la distance euclidienne

Conclusion
Le rejet d'eau chaude en provenance de la centrale électrique de la région, favorise la prolifération du phytoplancton, premier maillon de la chaîne alimentaire en mer. Cette prolifération pourrait être à son tour, à l'origine des blooms de méduses inhabituellement enregistrées ces dernières années dans la région.

References
1 - Caroppo C., Fiocca P., Sammarco P., Pastore M., et Magazzù G., 1998. Evaluzione delle comunità fitoplanctoniche costiere nell'Adriatico meridionale. *Biol. Mar. Medit.*, 5 (1) : 239-245.
2 - Chuanga, Y.L., Yanga, H.H et Lin, H.J., 2008. Effects of a thermal discharge from a nuclear power plant on phytoplankton and periphyton in subtropical coastal waters. *Journal of Thermal Biology*. Volume 33, pp 385-394.
3 - Cironi, R., Ioannilli, E., et Vitali, R., 1995. Assesment of effects of costal power plants on marine biological resources in italy. In: Della Croce, N., Connel, S., Abel, R., (Eds.), Coastal ocean space utilization, E et Fn Spon, London: 313-329.
4 - Innamorati, M., Nuccio, C., Lenzi Grillini, C., De Pol, M., et Mannucci, M., 1989. Biomassa, produzionne e specie fitoplanctoniche nel mare antistante lo scarico termico della centrae electrica di Torre del Sale (Golfo di Follonica). Resoconti dei rilevamenti in mare, Firenze, 5 : 1-45.
5 - Ioannilli, E., 1993., Valutazione del carico termico ammissibile. In: R. Marchetti (Ed.), Ecologia Applicata, CittàStudi, Milano: 739-754.
6 - Marano, G., De Zio, S., Pastorelli, A.M., Rizzi, E., Rositani, L., et Ungaro, N., 2000. Effects of thermal discharge on marine ecosystems: A case study from a costal power station in southern Italy. Oebalia, Vol. XXVI: 15-34.

CARACTERISATION MORPHOMETRIQUE DE *SCORPAENA PORCUS* POISSON SCORPAENIDAE (LINNE, 1758) SUR LES COTES TUNISIENNES

Myriam Ben Hassena [1]*, Rafika Fehri-Bedoui [1], Ibtissem Hammami [1] and Oum Kalthoum Ben Hassine [1]
[1] Faculté des sciences de Tunis, 2092, Tunisia - myriam.ben.hassena@gmail.com

Abstract
Une analyse factorielle discriminante des données morphométriques a été réalisée sur trois échantillons, composés au total de 90 spécimens de *Scorpaena porcus* (Linné, 1758) (Scorpaenidae), collectés à partir des apports de pêche côtière de trois sites, localisés respectivement au nord, à l'est et au sud du pays. Cette analyse a révélé l'absence d'homogénéité totale entre les trois échantillons.
Keywords: Analytical Methods, Biometrics, Mediterranean Ridge, Fishes

Bien que les Scorpaenidés peuplent l'ensemble du littoral tunisien, les études biologiques se rapportant à cette famille ont concerné uniquement trois espèces (*S. porcus*, *S. scrofa* et *S. notata*) de la région Sud [1]. Notre objectif étant de caractériser les populations des côtes tunisiennes, nous avons donc mené une analyse comparative des données relatives aux caractères morphométriques de *S. porcus* [2], provenant de trois régions littorales tunisiennes, Nord, Est et Sud. Le nombre de spécimens de *S. porcus*, collectés le long des côtes Nord, Est et Sud est respectivement de 31, 33 et 26. Tous les spécimens ont été photographiés pour être traités à l'aide du logiciel visilog. Des points décrits sur le corps des poissons ont été utilisés pour construire un réseau de distances selon la méthode de Truss [3]. 18 points repères, déterminant 36 distances, ont été ainsi établis et mesurés. Une transformation logarithmique des données morphométriques a été réalisée pour augmenter la linéarité et la normalité [4]. Ces données ont été transformées selon la formule suivante [5] : $V_{trans} = logV - \beta (\log LS - \log LS_{moy})$, où V_{trans} est la mesure transformée ; V est la mesure originale ; β est la pente de régression de la relation (Log V/log LS) ; LS est la longueur standard du poisson ; LS moy est la moyenne des LS. Les distances transformées ont servi à réaliser une analyse factorielle discriminante (AFD) [6], au moyen du logiciel R. Les deux premiers axes de l'analyse factorielle discriminante absorbent 68,45 % de la variabilité totale. Les résultats obtenus indiquent l'existence de deux groupes morphologiquement différents de *S. porcus* : le premier est représenté par l'échantillon de la région Sud, le deuxième par les deux échantillons des régions Est et Nord.

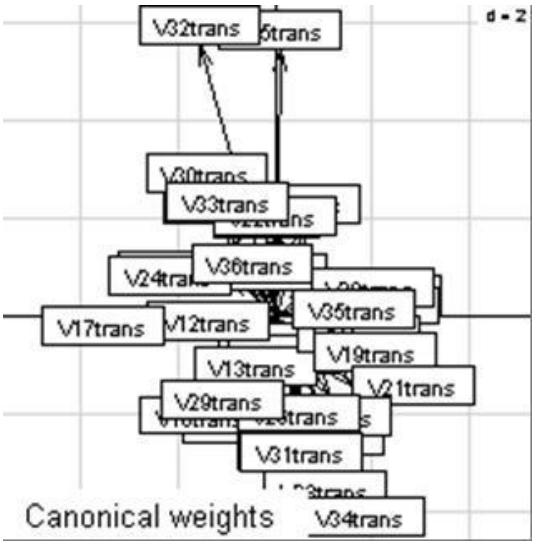


Fig. 1. Contribution des différentes distances représentant les caractères morphométriques dans la formation des axes discriminants de l'AFD

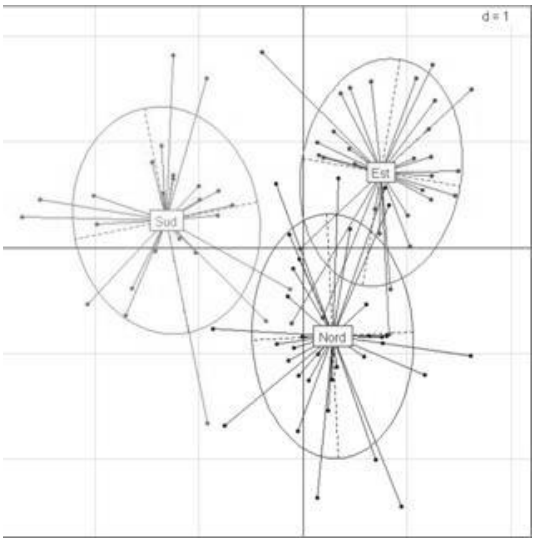


Fig. 2. Dispersion des individus définis par les variables métriques dans le plan de l'AFD selon les régions Nord, Est et Sud

Les résultats de notre analyse discriminante mettent en évidence une différenciation significative entre deux groupes de *S. porcus* Nord-est et Sud. L'absence d'homogénéité totale de l'espèce pourrait être interprété comme étant le résultat du caractère sédentaire de *S. porcus*.

References
1 - Bradai M.N., 1989. Contribution à l'étude écobiologique des Scorpaenidae (Poissons téléostéens) du golfe de Gabès. Thèse Doct. Spécialité Biol. Marine Océanogr. Fac. Sci. Sfax.
2 - Hureau J.C. and Litvinenko N.I., 1986. Scorpaenidae. *In*: Fishes of the North- Eastern Atlantic and the Mediterranean (Whitehead P.J.P., Bauchot M.L., Nielson J. and Tortonese E, (edit.), UNESCO, 3: 1211-1229.
3 - Strauss R.E. and Bookstein F.L., 1982. The truss: body form reconstruction in morphometrics. *Syst. Zool*. 31: 113-135.
4 - Pimentel R.A., 1979. The Multivariate Analysis of Biological Data. *Biometrics* 38, No. 3, Special Issue: Analysis of Covariance (Sep., 1982), pp 869-870.
5 - Reist J.D., 1985- An empirical evaluation of several univariate methods that adjust for size variation in morphometric data. *Can J. Zool*, 63: 1429–1439.
6 - Hair Jr., Anderson R., Tatham R. and Black W., 1996. Multivariate Data Analysis with Readings. Prentice Hall Inc., New Jersey.

LES BRYOZOAIRES ÉPIPHYTES DES HERBIERS À *POSIDONIA OCEANICA* DES CÔTES TUNISIENNES

Dorsaf Ben Ismail [1]*, Oum Kalthoum Ben Hassine [1] and Jean-loup D'hondt [2]

[1] Unité de recherche Biologie, Ecologie et Parasitologie des Organisme Aquatique, Faculté des Sciences de Tunis, 2092, Tunisie - dorsaf.ghriss@gmail.com

[2] Département milieux et peuplements aquatiques, Muséum national d'histoire naturelle 55 rue de Buffon 75005 Paris, France

Abstract

Dans ce travail, nous nous sommes intéressés à l'étude des Bryozoaires des herbiers de Posidonie au niveau de cinq sites, répartis sur les côtes Nord-est et Sud-est de la Tunisie. Un échantillonnage saisonnier a été effectué durant une période de trois ans. Au cours de ce suivi, nous avons recensé 90 espèces de Bryozoaires appartenant aux trois classes Cheilostomona, Cyclostomona et Ctenostomona.

Keywords: Bryozoa, Posidonia

Les herbiers de posidonie sont traditionnellement considérés comme la superposition de trois biotopes : la matte, les rhizomes et les feuilles. Seules les deux dernières strates sont concernées par la faune des Bryozoaires [1]. L'objectif de cette étude est de contribuer à la connaissance de la richesse spécifique de la communauté des bryozoaires épiphytes des herbiers de Posidonie de la côte tunisienne et à la caractérisation de la faune Bryozoologique de chaque compartiment de l'herbier. Pour cela, un échantillonnage saisonnier a été effectué durant une période de trois ans (octobre 2005 - décembre 2008) au niveau de cinq sites, répartis sur les côtes Nord-est (Bizerte, Gammarth, Sidi Raies, El Hawaria) et Sud-est (Kerkennah) de la Tunisie. Les prélèvements ont été effectués, au cours de plongées sous-marines, au moyen d'un quadrat de 20 cm de côté [2]. Afin de caractériser l'état de l'habitat et du peuplement, nous avons calculé la richesse spécifique (nombre d'espèces), l'indice de Simpson (Is), l'indice de Shannon - Weaver (H') et l'indice d'équitabilité. Au total, nous avons recensé 90 espèces appartenant à trois classes : Cheilostomata (73 espèces), Cyclostomata (13 espèces) et Ctenostomata (4 espèces). Parmi les Cheilostomata, les trois espèces, *Electra posidonia*, *Microporella ciliata* et *Turbicellepora avicularis*, dominent au niveau des cinq sites. Les espèces observées sur les Rhizomes sont plus importantes en nombre (54) que celles trouvées sur les feuilles (36). Six espèces (*Copodozum planum*, *Pherusella tubulosa*, *Microporella ciliata*, *Crisia fistulosa*, *Schizomavella hastata* et *Reptadeonella violacea*) ont été récoltées aussi bien sur les rhizomes que sur les feuilles. Le dendrogramme de la classification hiérarchique (Fig.1) a permis de séparer deux assemblages : le premier est formé par le site de Kerkennah et le second est composé par les quatre autres sites.

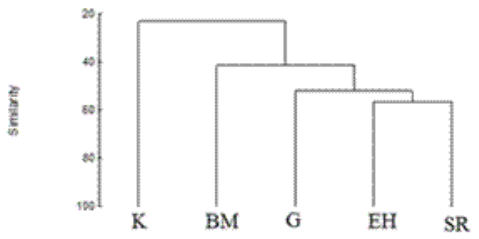


Fig. 1. Dendrogramme de la classification hiérarchique des cinq stations étudiées (K : Kerkennah ; BM: Bizerte ; G : Gammarth ; SR : Sidi Rais)

Le test de Simper a montré que *E. posidonia*, *A. ledigera* et *M. ciliata* sont les espèces qui ont le plus contribué à cette distribution. L'ensemble des résultats obtenus sont conformes aux observations d'autres auteurs en Méditerranée [1], [3] et [4]. La riche faune rencontrée des bryozoaires épiphytes reflète l'intérêt écologique de l'herbier à *Posidonia oceanica*.

Tab. 1. Liste des espèces recensées

CHEILOSTOMES	*schizoporella magnifica*	*Pentapora fascialis*
Copodozum planum	*Schizoporella unicornis*	*Parellisina raibauti*
Beania hirtissima	*Turbicellepora magnicostata*	*Copodozum tenuirostre*
caberia boryei	*Crassimarginatella solidula*	*Parasmittina raiguii*
Microporella ciliata	*Collarina Balzaci*	**CTENOSTOMES**
Electra posidoniae	*Celleporina Hassallii*	*Amatia lendigera*
Chorizopora brongniartii	*Bugula neritina*	*Pherusella tubulosa*
Haplopoma graniferum	*Scrupocellaria scruposa*	*Nolleia dilata*
Fenestrulina Joannae	*Scrupocellaria bertholletti*	*Zoobothryon verticillatum*
Puellina gattyae	*Bugula sp*	**CYCLOSTOMES**
Atea truncata	*Watersipora subovoidea*	*Annectocyma major*
Celleporina globulosa	*Cellepora pumicosa*	*Diplosolen obelia*
Schizoporella dunkeri	*Beania magellanica*	*Lichenopora verrucaria*
Pentapora ottomulleriana	*Dentiporella sardonica*	*Disporella hispida*
Schizobrachiella sanguinea	*Hippaliosina depressa*	*Entalophorecia deflexa*
Turbicellepora avicularis	*Escharina vulgaris*	*Microecia suborbicularis*
Stylopoma sp	*cryptosula pallasiana*	*Entalophoroecia gracilis*
Hippopodinella lata	*Cellaria fistulosa*	*Filicrisia geniculata*
Turbicellepora camera	*Bugula stolonifera*	*Annectocyma tubulosa*
Beania robusta	*Atea sica*	*Crisia fistulosa*
Myriapora truncata	*Beania mirabilis*	*Crisia ramosa*
Scrupocellaria scrupea	*Cribrilaria punctata*	*Lichenopora radiata*
Haplopoma bimucronatum	*Schizomavella linearis*	*Crisia occidentalis*
Schizoporella errata	*Cellaria salicorina*	
Schizomavella teresae	*Celleporina caminata*	
Chlidonia pyriformis	*Electra verticillata*	
Scrupocellaria delilii	*Clapensia nobilis*	
Stylopoma inchoans	*Reptadeonella violacea*	
Parasmittina tropica	*Anarthropora monodon*	
Scrupocellaria macrorhynchus	*Microporella orientalis*	
Cribrilaria innominata	*Watersipora complanata*	
Cellaria salicornioides	*Schizoporella longirostris*	
Arthropoma cecilii	*Margaretta cereoides*	
Schizomavella hastata	*Sertella couchii*	
Schizomavella cuspidata	*Escharella sp*	

References

1 - Harmelin J. G., 1973. Bryozoaires de l'herbier de Posidonies de l'île de Port-Cros. *Rapp.Comm.int. Mer Médit.*, 21 : 675-677.

2 - Somaschini A., Gravina M.F. et Ardizzone G.D., 1994. Polycheate depth distribution in a Posidonia oceanica bed (rhizome and matte strata) and neighbouring soft and hardbottoms. P.S.Z.N.I : *Mar. Ecol.*, 15(2) : 133-151.

3 - Kocak F., Balduzzi A., and Avni Benli H., 2002. Epiphytic bryozoan community of *Posidonia oceanica* (L.) Delile meadows in the northern Cyprus (Eastern Mediterranean). *Indian Journal of Marine Science.*,31(3): 235- 238.

4 - Hayward P. J., 1974. Observation on the Bryozoan Epiphytes of *Posidonia oceanica* from the Island of Chios (Agean Sea). *Docum.lab. Géo. Fac. Sci. Lyon.* 2: 347-356.

CARACTERISATION BIOCHIMIQUE DE QUELQUES D ESPECES D HOLOTHURIES DES COTES TUNISIENNES

Hanen Ben Ismail [1]*, Jamila Ben Souissi [1], Amine Mersni [2] and Sami Fattouch [2]
[1] Institut National Agronomique de Tunisie. 43 Avenue Charles Nicolle, 1082 El Mahrajène, Tunisie. - benismailhanen@yahoo.fr
[2] Institut National des Sciences Appliquées et de Technologie (INSAT). Rue de la Terre, Centre Urbain Nord, BP676, 1080 Tunis Cedex.Tunisie.

Abstract
La caractérisation biochimique d'*Holothuria polii* et *d'Holothuria tubulosa*, récoltées au niveau de la côte Est de la Tunisie a permis de noter quelques différences entre les deux espèces et de montrer leur importance nutritionnelle (teneur en protéines de l'ordre de 8 g/100g, teneur en lipides de l'ordre de 10 g/100g et une teneur moyenne en sucres de 15 mg/g). Leur teneur moyenne en polyphénols est de 50 µg/g. Ces substances présentent une activité antioxydante non négligeable qui permettrait une éventuelle valorisation industrielle de ces espèces.
Keywords: Chemical Analysis, Echinodermata, Infralittoral

Introduction - Les holothuries des côtes tunisiennes constituent une faune méconnue aussi bien sur le plan biologique qu'écologique. Parmi les 11 espèces inventoriées en Tunisie [1], *Holothuria polii* et *Holothuria tubulosa* sont à la fois fréquentes et abondantes le long du littoral Est. Ce travail a pour objectif la valorisation nutritionnelle de ces organismes marins.

Matériel et méthodes - Les holothuries étudiées proviennent de la région de Monastir (Méditerranée centrale). Les spécimens ont été récoltés vivants par plongée en scaphandre autonome à 7 m de profondeur entre le mois d'août 2008 et janvier 2009. Ils ont été directement congelés à -20°C jusqu'à leur analyse. Après tri et identification [2] (figure 1), les individus ont été disséqués. Seule la cuticule a été récupérée et découpée en morceaux. La teneur en protéines a été dosée par la technique « Kjeldahl » [3]. L'extraction et la quantification des lipides totaux (matières grasses) des holothuries ont été réalisées par Soxhlet [4]. Les sucres totaux sont dosés par la méthode au DNS (acide dinitrosalicylique) [5]. Le dosage des polyphénols totaux a été réalisé en utilisant le Folin Ciocalteu [6]. Le dosage de l'activité antioxydante a été réalisé selon Brand-Willizms [7] par réduction du DPPH° (2,2-diphényl-1-picryl-hydrazyl) et en utilisant comme antioxydant standard le TROLOX.

Résultats et discussion - Les analyses effectuées montrent que les teneurs en protéines pour les deux espèces d'holothuries sont proches : 7,78 g/100g pour *Holothuria polii* et 8,56 g/100g pour *Holothuria tubulosa* (figure 2). Par conséquent, ces 2 espèces ne constituent pas une source importante en protéines comparativement aux autres organismes marins [8], [9]. Toutefois, la teneur en matières grasses est plus élevée chez *Holothuria polii* (11,7 g/100g) comparativement à *Holothuria tubulosa* (9,5 g/100g). Les holothuries constituent une source appréciable en lipides comparées aux bivalves comestibles [8], [9]. Les sucres totaux représentent des teneurs faibles (13,75 mg/g pour *Holothuria tubulosa* et 16,2 mg/g pour la seconde espèce). Quant à la teneur en polyphénols, elle est de 64 µg/g pour *Holothuria tubulosa* et de 40 µg/g pour *Holothuria polii*. Les composés phénoliques peuvent avoir de nombreuses propriétés physiologiques et peuvent jouer un rôle anti-allergène, anti-inflammatoire, antimicrobien et antioxydant. En effet, l'étude des propriétés antioxydantes des substances phénoliques chez *Holothuria tubulosa* montre un pouvoir anti-radicalaire près de 2 fois plus important que celui d'*Holothuria polii* (respectivement de 24 et 14 mM équivalent Trolox).

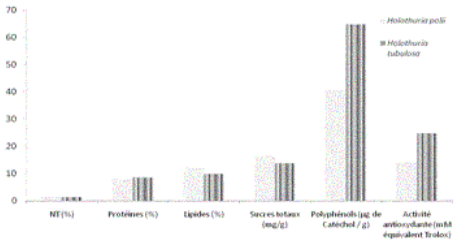


Fig. 1. Caractéristiques physico-chimiques et biochimiques des espèces d'holothuries isolées de Tunisie

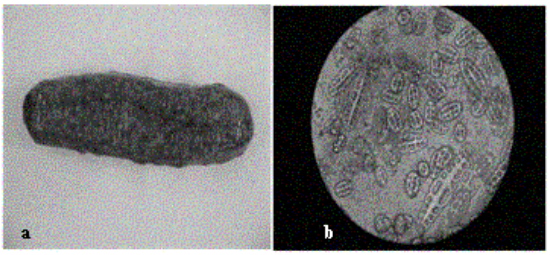


Fig. 2. (a) *Holothuria polii* récoltée à Monastir (janvier 2009); (b) spicules *Holothuria polii*

Conclusion - La liste des espèces aquatiques utilisables pour des extractions de molécules actives ne cesse de s'enrichir. Elle comporte essentiellement des groupes d'espèces méconnues et n'ayant pas d'intérêt halieutique majeur. Dans ce contexte, une étude préliminaire sur 2 espèces d'holothuries des côtes tunisiennes a été entreprise pour leur valorisation. Les résultats de cette étude mettent en évidence des propriétés nutritionnelles intéressantes. Nos recherches futures seront axées sur l'extraction d'autres molécules actives comme les saponines.

References
1 - Ben Mustapha K., Hattour A., Mhetli M., El Abed A. and Tritar B., 1999. Etat de la bionomie benthique des étages infra et circalittoral du golfe de Gabès. *Bull. Inst. Nat. Sci. Tech. Mer Salammbô*, 26: 5-48.
2 - Massin C ., Mercier A. and Hamel J. F., 2000. Ossicle change in *Holothuria scarba* with a discussion of ossicle evolution within the *Holothuriidae* (echinodemata). *Acta Zoologica*., 81 (1):77-91 .
3 - AFNOR, 1972. Dosage de l'azote total. NF V 04-407, AFNOR, Paris, France.
4 - AFNOR, 1968. Détermination de la teneur en matière grasse totale. NF V 04-402, AFNOR, Paris, France.
5 - Luchsinger W. W. and Cornesky R. A., 1962. Reducing, power by the dinitrosalicylic acid method. *Analytical Biochemistry*, 4(4) : 346-347.
6 - Lopez-Martinez L. X., Oliart-Ros R. M. , Valerio-Alfaro G., Lee C.-H. , Parkin K. L. and Garcia H. S., 2009. Antioxidant activity, phenolic compounds and anthocyanins content of eighteen strains of Mexican maize. *Food Science and Technology*, 42:1187–1192 .
7 - Brand-Williams, B. W., Cuvelier M. E. and Berset C., 1995. Use of a free radical method to evaluate antioxidant activity. *Lebensmitel. Wissenschauft und Technologie*. 28: 25–30 .
8 - Linehan L.G., O Connor T.P. and Burnell G., 1999. Seasonal variation in the chemical composition and fatty acid profile of pacific oysters (*Crassostrea gigas*). *Food chemistry*, 64 : 211-214 .
9 - Orban E., Di Lena G., Nevigato T., Casini I., Caproni R., Santaroni G.and Giulini G., 2006. Nutritional and commercial quality of the striped venus clam, *Chamelea gallina*, from the Adriatic sea. *Food Chemistry*, 101 : 1063-1070 .

LES ESPECES NON INDIGENES DU MACROBENTHOS DES LAGUNES DU SUD-EST TUNISIEN : POINT SUR LA SITUATION

Jamila Ben Souissi [1]*, Chirine Kahri [1], Mohamed Ben Salem [2] and Jeanne Zaouali [1]
[1] Institut National Agronomique de Tunisie, Tunis, 1082, Tunisie - bensouissi.jamila@inat.agrinet.tn
[2] Faculté des Sciences de Tunis, 2092, Tunisie

Abstract
Des observations récentes faites au cours de campagnes de prélèvements médio et infralittoraux d'organismes benthiques dans des lagunes côtières tunisiennes nous ont permis de mettre en évidence l'installation de 4 crustacés d'origine lessepsienne signalés pour la première fois en Tunisie et sur la rive Sud de la Méditerranée (amphipode *Caprella scaura)* et en Méditerranée centrale (amphipodes *Maera hamigera*, *Gammaropsis togoensis* et l'isopode parasite *Anilocra pilchardi)*.
Keywords: Crustacea, Biodiversity, Gulf Of Gabes, Infralittoral, Lagoons

Les prospections menées régulièrement au niveau de la frange littorale marine tunisienne et dans les milieux lagunaires (Boughrara et les Bibans) ont permis d'inventorier parmi les communautés benthiques médio et infralittorales des substrats meubles et rocheux trois nouvelles espèces d'amphipodes et un isopode. La liste de l'amphipodofaune de Tunisie ne cesse de s'enrichir. Des investigations récentes font état de 2 Amphipodes lessepsiens nouveaux *Elasmopus pectenicrus* et *Stenothoe gallensis* [1]. Ces 2 espèces sont récoltées en nombre important dans nos échantillons en provenance de la lagune de Boughrara surtout parmi les algues brunes. De manière concomitante, nos prélèvements regroupent des espèces non encore inventoriées :

Gammaropsis togoensis (Schellenberg, 1925). Cet amphipode originaire des océans Indien et Pacifique et des côtes Est et Ouest atlantiques a été signalé uniquement en Méditerranée orientale en Israël et en Turquie [2], [3]. Nous avons récolté massivement cette espèce (139 individus) en octobre 2009, à Boughrara, sous les pierres à des profondeurs n'excédant pas 1,5m. La taille des spécimens se situe entre 3,8 à 4,2 mm pour les mâles et 2,5 à 2,8 mm pour les individus femelles.

Caprella Scaura (Templeton, 1836) a été trouvée au cours de la saison estivale dans les lagunes de Boughrara et des Bibans (juin à septembre 2009). Cet amphipode euryhalin originaire de l'océan Indien [4], prospère dans les stations peu profondes, principalement parmi les rhodophycées appartenant aux genres *Gracillaria* et *Polysiphonia.* Un total de 287 spécimens ont été échantillonnés avec une densité moyenne oscillant entre 7 et 24 individus/m^2. C'est une espèce des communautés "fouling" occupant de nombreux habitats comme la végétation marine et les bryozoaires du genre *Bugula* [5]. Cet amphipode a été uniquement signalé dans plusieurs régions des côtes européennes dont la lagune de Venise [6], [7]. Nous le mentionnons pour la première fois sur la rive Sud de la Méditerranée (Fig. 1).

Maera hamigera (Haswell, 1880). Cette espèce a été récemment trouvée au niveau des côtes libyennes [8]. Nous avons récolté dans la lagune des Bibans quelques rares spécimens (11 individus) associés aux amphipodes lessepsiens *Elasmopus pectenicrus* et *Stenothoe gallensis.*

Anilocra pilchardi est un isopode, cymothoïdae parasite. Il a été récolté lors de nos prospections sur de nombreuses espèces ichtyologiques autochtones et exotiques pêchées dans les lagunes de Boughrara et des Bibans. Les poissons hôtes pour cet ichtyoparasite sont nombreux. Nous l'avons trouvé fixé par ordre décroissant de préférence sur les mugilidae (*Chelon labrosus* et *liza saliens*), sur les Sparidae (*Diplodus sargus* et *Boops boops*), sur les Clupéidae (*Sardina pilchardus* et *Sardinella aurita*) et sur l'Hemiramphidae *Hemiramphus far*. Ce parasite hématophage non spécifique a été signalé seulement en Méditerranée orientale (côtes libanaises) [9]. Cet isopode semble bien acclimaté et se reproduit dans son nouveau biotope (tous les stades ont été observés, adultes, sub-adultes et femelles ovigères).

La faune marine tunisienne montre des modifications importantes qui se traduisent par l'introduction et l'acclimatation massive d'espèces non indigènes, surtout d'origine lessepsienne. Ce phénomène de bioinvasion s'est accéléré lors des dernières décades probablement en relation avec le réchauffement des eaux marines et l'intensification du trafic maritime.



Fig. 1. Distribution méditerranéenne actuelle de l'amphipode *Caprella Scaura*

References
1 - Zakhama R., Sghaier Y.R. and Charfi F., 2008. Première signalisation de deux Amphipodes lessepsiens en Tunisie: *Elasmopus pectenicrus* (Bate, 1862) et *Stenothoe gallensis* Walker, 1904. Xèmes Journées Scientifiques des Sciences de la Mer & 1ère rencontre Tuniso-Française d'ichtyologie, Sousse, 20-23 décembre 2008 : 91.

2 - Sorbe J.C., Basin A. and Galil B.S., 2002. Contribution to the knowledge of the amphipoda (crustacea) of the Mediterranean coast of Israel. *Israel Journal of Zoology* 48(1): 87-110.

3 - Bakir K., Sezgin M. and Katagan T., 2007- Contribution to the knowledge of the alien amphipods off the Turkish coast *Gammaropsis togoens*is (Schellenberg, 1925). *Aquatic Invasions.*, 2(1): 80-82.

4 - Martinez J. and Adarraga I., 2008. First record of invasive caprellid *Caprella scaura* (Templeton,1836) (Crustacea: Amphipoda; Caprellidae) from the Iberian Peninsula. *Aquatic Invasions*., 3(2): 165-171.

5 - Mizzan L., 1999. Le specie alloctone del macrozoobenthos della laguna di Venezia: il punto della situazione. *Bollettino del Museo civico di Storia Naturale de Venezia*., 49: 145-177.

6 - Danesi P. , Gola G. and Tagnin L., 1999. Structure e dinamiche del macrobenthos ai confini dei partiacque nel bacino centrale della laguna di Venezia. *In* : Bon M., Sburlino G. And Zcarello V. (eds), Aspetti Ecologici et Naturalistici dei sistemi lagunairi e Costieri. Atti13. Conv. Gruppo Ecologia di Base "G. Gardio" Venezia pp 267-269.

7 - Occhipinti-Ambrogi A., 2000. Biotic invasions in a Mediterranean lagoon. *Biological Invasions.*, 2: 165-176.

8 - Ortiz M. and Petrescu I., 2007. The marine Amphipoda (Crustacea: Gammaridae) of the republic of Libya Southern Mediterranean. *Travaux du Muséum National d'Histoire Naturelle* « Grigore Antipa » vol L : 11-23.

9 - Bariche M. and Trilles J.P., 2006. *Anilocra pilchardi* n. sp., a new parasitic Cymothoïd Isopod from off Lebanon (Eastern Mediterranean) *Systematic Parasitology*., 64: 203-214.

PEUPLEMENTS ASSOCIES A *CYSTOSEIRA AMANTACEA* STRICTA DANS LA REGION OUEST ALGEROISE (TIPAZA)

Myriam Benali [1] and Chafika Rebzani Zahaf [1]*

[1] Faculté des Sciences Biologiques (FSB) Université Sciences et Technologies Houari Boumedienne (USTHB), Alger, 16111, Algérie - chafikarebzanizahaf@gmail.com

Abstract

Une étude de la biodiversité faunistique associée à la Chromobionte, endémique de la Méditerranée, *Cystoseira stricta*, de la région de Tipaza a été effectuée au niveau de l'étage infralittoral supérieur de quatre sites. Elle a permis d'identifier 117 espèces quantitativement dominées par les Crustacés.

Keywords: Endemism, Algae, Bio-Indicators, Zoobenthos, Biodiversity

Introduction

L'espèce *Cystoseira stricta* constitue l'élément fondateur d'un écosystème remarquable de l'infralittoral supérieur ; cette espèce est directement soumise à l'impact anthropique croissant dans la région d'étude. L'analyse de la biodiversité qui le compose est un outil appréciable pour la caractérisation du milieu marin et de sa biosurveillance. L'intérêt porté sur l'étude de la faune associée aux Cystoseires est nouveau en Algérie. Cette étude concerne 4 sites de référence de la région de Tipaza : Ain Tagourait, Anse de Kouali, Anse des Carrières et El Hemdania ; ces zones sont considérées comme étant d'intérêt stratégique majeur pour la conservation et la protection de la diversité biologique marine. Les objectifs sont la localisation et une meilleure connaissance de l'identité et de la structure de cette biocénose formée par une espèce méditerranéenne endémique et vulnérable [3].

Matériels et méthodes

Les denses recouvrements de *Cystoseira stricta* observés au niveau de la zone infralittorale supérieure des quatre stations d'études ont été investis. Une surface homogène de $2m^2$ par saison (été/hiver) et par station a été délimitée pour les 5 réplicats (20X20cm). Un grattage jusqu'à la roche a été effectué. Le tri du macrobenthos s'est fait sur tamis à mailles d'1mm de diagonale. La biomasse sèche des Cystoseires, par mètre carré, a été estimée pour chaque site.

Résultats et discussions

Les biomasses sèches moyennes des Cystoseires ont été estimées entre 2344 et 3460g MS/m^2, avec des densités supérieures en été. Bellan-Santini, (1969) [1] estimait cette biomasse moyenne à environ 2 200g MS/m^2 à Marseille. Un total de 117 espèces a été recensé en association à *Cystoseira stricta* au niveau des quatre sites étudiés. Un nombre total de 8 485 individus est noté, ils sont répartis en 39 espèces de Crustacés, 37 de Mollusques, 23 de Polychètes, 5 d'Echinodermes, 6 de Cnidaires, 3 de Sipunculidés, 2 de Spongiaures, une de Némerte et une espèce indéterminée de Bryozoaire. Le nombre d'espèces le plus important a été enregistré à l'Anse de Kouali (78 espèces), suivi d'Ain Tagourait (71 espèces), d'El Hemdania (63 espèces) et enfin de l'Anse des Carrières (61 espèces). Cette analyse de la biodiversité met en évidence une richesse spécifique relativement importante au sein des peuplements à Cystoseires, particulièrement ceux à *Cystoseira stricta*. Selon Bellan-Santini [1], les conditions d'hydrodynamisme intense favorisent le développement d'une faune importante qui trouve « refuge » au sein du peuplement à *C. stricta*. Il considère que ce peuplement de mode battu ne permet le développement que d'espèces fortement adaptées à ce type de biotope, d'où sa relative pauvreté du point de vue qualitatif.

Le groupe zoologique dominant est celui des Crustacés au niveau de toutes les stations. Néanmoins, les sites d'Ain Tagourait et d'El Hemdania présentent les dominances les plus élevées (supérieure à 60%) pour ce groupe. Les stations Anse de Kouali 3 et Anse des Carrières ont respectivement des dominances de 59,43% et 58,44%. Bellan-Santini [4] indique qu'une richesse spécifique et des dominances quantitatives élevées en Crustacés reflètent un milieu salubre et des eaux pures. L'auteur fixe une barrière moyenne de 15 espèces à cette fin. D'un point de vue spécifique, les résultats obtenus dans cette présente étude indiquent des milieux relativement salubres, avec plus de 18 espèces par site.

Le groupe écologique regroupant les espèces d'Algues Photophiles (AP) domine largement la macrofaune. L'analyse a révélé la présence de 9 espèces communes aux quatre sites dont 4 sont particulièrement importantes. Les Crustacés caractéristiques des eaux pures et agitées *Hyale pontica*, et à moindre degré *Caprella liparotensis*, dominent pratiquement au niveau de tous les sites. La Polychète opportuniste *Platynereis dumerilli*, espèce sentinelle selon Bellan [2] , est fortement représentée aux sites Anse de Kouali 3 et Anse des carrières témoignant d'une relative altération de la qualité des eaux ; le premier site étant situé à proximité d'un complexe touristique, le second près de oued Nador (effluents importants du bassin versant). L'analyse des groupes trophiques a révélé la nette prépondérance des brouteurs.

Les valeurs des indices de diversité (Shannon, H' et Equitabilité, E) et les DRF révèlent un peuplement diversifié qui tend à l'équilibre.

Pour les principales espèces, la présence de certaines espèces a permis d'évaluer la situation écologique des sites étudiés. Ainsi, le Crustacé *Elasmopus pocillimanus* est dominant à El Hemdania où il supplante le Crustacé de mode agité *Hyale pontica*, témoignant probablement d'une affinité pour des eaux moins agitées. Les données concernant les peuplements infralittoraux superficiels, entre autre le peuplement à *Cystoseira stricta* (mode battu) ont mis en évidence que *Jassa falcata* affectionnait probablement les zones à fort hydrodynamisme et non les zones polluées au sens strict. Dans cette étude, *Jassa falcata* est une espèce fréquente au sein des peuplements à *Cystoseira stricta*, la dominance de *Jassa falcata* varie entre 1,08% (El Hemdania) et 2,59% (Anse de Kouali 3).

Conclusion

L'espèce *Cystoseira stricta* est une espèce à forte valeur patrimoniale, c'est un atout de classification des zones où elle a été identifiée dans le rang d'espaces d'intérêt prioritaire de protection ; ses biomasses importantes, comparables à celles enregistrées dans d'autres régions méditerranéennes, justifient encore plus la vulnérabilité et la grande valeur écologique de ces sites. L'intérêt des peuplements qui lui sont associés et leur étude est démontré par la richesse spécifique importante qu'ils recèlent, mais aussi par la particularité de cette faune qui permet de caractériser le milieu du point de vue hydrodynamique (mode battu) et du degré de salubrité. Si les espèces indicatrices d'eaux pures sont dominantes au sein de ces sites, il n'en demeure pas moins que des espèces sentinelles indicatrices de perturbations contribuent fortement au peuplement faunistique à l'Anse des Carrières et à l'Anse de Kouali, constituant un premier signal d'une altération de l'écosystème. Pour la conservation des types d'habitats marins naturels et remarquables et sur la base des critères méditerranéens, des fiches techniques d'évaluation écologique ont été établies pour chaque site. Ces fiches synthétisent les données scientifiques recueillies avec pour finalité de fournir des documents de prises de mesures de protection et de conservation à l'usage des gestionnaires.

References

1 - Bellan Santini D., 1969. Contribution à l'étude des peuplemements infralittoraux sur substrat dur rocheux (Etude qualitative et quantitative de la frange supérieure) *Rec. Trav. St. mar*. Endoume, fasc.63, *Bull*. 47 : 5-294.

2 - Bellan G., 1980. Annélides Polychètes des substrats solides de trois milieux pollués sur la côte des Provences (France) : Cortiou, golfe de Fos, Vieux Port de Marseille. *Téthys, 9(3): 267-278*.

3 - Boudouresque C. F., Beaubrun P. C., Relini G., Templado J., Van Klaveren M. C., Van Klaveren P., Walmsley J. G., Zotier R., 1996. Critères de sélection et liste révisée des espèces en danger et menacées (marines et saumatres) en Méditerranée. PNUE – CAR/ASP Tunis, Gis Posidonie Publishers, Marseille, Fr : 1-73.

4 - Bellan Santini D., 1980. Relationship bettween populations of amphipods and pollution. Mar.Poll. Bull. 11, 224-227.

AGE, CROISSANCE ET REPRODUCTION DU SAR COMMUN DIPLODUS SARGUS SARGUS (SPARIDAE) DES COTES DE L'EST ALGERIEN

Wafa Benchalel [1]* and Mohamed Hichem Kara [1]

[1] Laboratoire bioressources marines, Université Badji-Mokhtar, Annaba, El Hadjar, 23000 Algérie - wafachalel@yahoo.fr

Abstract

L'age, la croissance et la reproduction sont étudiés chez le sar commun *Diplodus sargus sargus (L., 1758)* des côtes Est de l'Algérie. La lecture des otolithes de 241 individus a permis de déterminer les paramètres de croissance par le modèle de Von Bertalanffy. La relation liant le poids à la taille est globalement isométrique. L'activité sexuelle a lieu de janvier à mai et la ponte au printemps (mars à mai). La première maturité sexuelle est acquise à partir d'une longueur totale (Lt_{50}) de 20 cm, quel que soit le sexe, et correspond à un âge d'environ 4 ans.

Keywords: Fishes, Algerian Basin, Growth, Reproduction

Introduction

Diplodus sargus sargus (L., 1758) est un poisson démersal assez commun et largement répandu dans l'ensemble du bassin méditerranéen [1]. De bonne valeur commerciale, il est très recherché par la pêche locale et joue un rôle écologique important au sein des écosystèmes côtiers qu'il occupe. Cette étude fournit les premières données sur l'âge, la croissance et la reproduction de *D. sargus sargus* sur les côtes Est de l'Algérie.

Matériel et méthodes

Un total de 241 individus (143 mâles et 98 femelles), de longueur totale comprise entre 11,2 et 34,6 cm et de poids total allant de 20,2 à 746 g, provenant de la pêche aux filets maillants, sont examinés. La détermination de l'âge est réalisée par otolithométrie. La longueur totale correspondant à chaque âge est rétro-calculée par la méthode de Lee [2]. Les croissances linéaire et pondérale sont ajustées au modèle de Von Bertalanffy [3]. Les paramètres $L\infty$, K et to sont déterminés par le programme Fisat II (version 1.2.2). La croissance relative est établie entre la longueur totale (Lt en mm) et le poids éviscéré (Pe en g) [4]. La relation taille-poids porte sur 440 individus (178 femelles et 262 mâles). La période de reproduction est déterminée pour les mâles (N = 262) et les femelles (N = 178) à partir de l'évolution du rapport gonado-somatique (RGS). La taille à la première maturité sexuelle est estimée.

Résultats et discussion

L'analyse des variations mensuelles de l'allongement marginal des otolithes chez les différents groupes d'âge, montre l'individualisation d'un seul anneau d'arrêt de croissance par an et se forme en juin. Les tailles des sars aux différents âges sont rétro-calculées, en tenant compte de l'existence d'une corrélation significative entre la longueur totale du poisson et le rayon de son otolithe ($r = 0,897$, $p \leqslant 0,01$). L'âge maximum des poissons péchés est de 10 ans (tab. 1). La croissance linéaire absolue est exprimée comme suit:

Femelles: $Lt = 354,1\ ()1\text{-}e^{-0,160\ (t + 0,605)})$

Mâles: $Lt = 351,4\ (1\text{-}e^{-0,161\ (t + 0,427)})$

Sexes confondus: $Lt = 363,9\ (1\text{-}\ e^{-0,154\ (t + 0,488)})$

La relation liant le poids éviscéré du poisson à sa taille est isométrique chez les deux sexes confondus, chez les mâles et chez les femelles:

Femelles: $Pe = 2,720.10\text{-}5\ Lt^{2,945}$

Mâles: $Pe = 1,900.10\text{-}5\ Lt^{3,009}$

Sexes confondus: $Pe = 2,240.10\text{-}5\ Lt^{2,987}$

Le suivi mensuel des valeurs moyennes du rapport gonado-somatique (fig. 1) montre que la reproduction de *D. sargus sargus* se déroule entre janvier et mai. Les valeurs maximales du RGS marquant la maturation des gonades sont enregistrées en mars (3,864) pour les femelles et en avril (4,443) pour les mâles. Cette période est identique à celle déterminée dans le golfe de Tunis [5]. Le sar commun se reproduit à partir d'une longueur totale (Lt_{50}) de 20 cm chez les femelles et 20,2 chez les mâles, ce qui correspond à un âge d'environ 4 ans. Cette taille est de 21 cm dans le golfe de Tunis.

Tab. 1. Longueurs retro-calculées chez *Diplodus sargus sargus* des côtes de l'Est de l'Algérie

	1	2	3	4	5	6	7	8	9	10
Femelles										
N	98	98	95	61	33	16	10	8	6	2
M	104,25	142,01	173,60	199,15	224,68	243,98	258,83	269,49	279,42	301,11
Et	13,17	17,66	16,78	15,17	14,71	12,35	18,27	18,92	10,85	22,14
Mâles										
N	143	139	119	79	43	19	13	7	3	-
M	104,71	140,85	173,08	197,86	222,23	242,80	256,96	270,29	283,92	-
Et	14,27	17,29	17,55	15,78	13,98	10,81	15,45	20,60	22,38	-
Sexes confondus										
N	241	237	214	140	76	35	23	15	9	2
M	104,52	141,33	173,31	198,96	227,38	245,54	257,97	274,53	287,59	301,11
Et	13,81	17,41	17,17	15,46	14,57	12,30	16,75	19,80	18,68	22,14

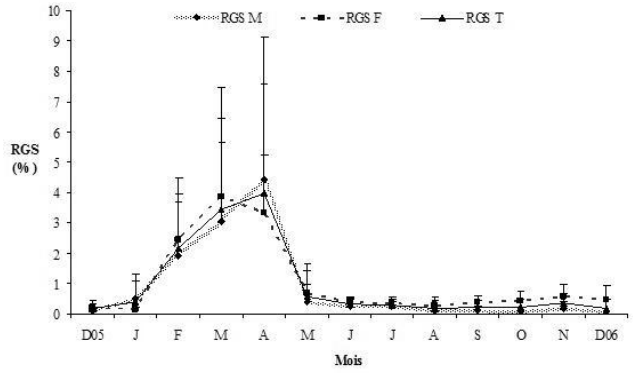


Fig. 1. Évolution mensuelle du RGS chez les femelles, les mâles et les sexes confondus de *Diplodus sargus sargus* des côtes de l'Est de l'Algérie

References

1 - Louisy P., 2005. Guide d'identification des poissons marins. Europe de l'ouest et Méditerranée. (eds) Eugen Ulmer. 430 p.

2 - Lee, R.M., 1912. A review of the methods of age and growth determination in fish by means ofscales. *Fisheries Fish Inves*. London, 2 (4): 32 p.

3 - Bertalanffy, L. Von., 1938. A quantitative theory of organic growth. *Hum.Bioi*, 10 (2): 181-213.

4 - Teissier, G., 1948. La relation d'allométrie: sa signification statistique et biologique. *Biometrics*, 4 (1): 14-53.

5 - Mouine N., Francour P., Ktari M.H. & N. Chakroun-Marzou., 2007. -The reproductive biology of Diplodus sargus sargus in the Gulf of Tunis (central Mediterranean). *Sci. Mar*., 71 (3): 461-469.

IMPACT DES CHANGEMENTS CLIMATIQUES ET DES ESPECES EXOTIQUES SUR LA BIODIVERSITE ET LES HABITATS MARINS AU LIBAN

Ghazi Bitar [1]*
[1] Faculté des Sciences, Université libanaise - ghbitar@ul.edu.lb

Abstract
Le changement climatique du bassin levantin et en particulier au Liban est un fait incontestable. Le Canal de Suez et le réchauffement global sont essentiellement à l'origine de l'arrivée et de l'établissement des espèces exotiques et par suite au changement biotique dans la région. Ces espèces à affinité tropicale ont contribué à la restructuration des peuplements et ont réussi à former des faciès particuliers. Plusieurs espèces y sont bien établies et présentent un comportement d'espèces envahissantes.
Keywords: Global Change, Species Introduction, Eastern Mediterranean

Introduction Depuis 78 ans, Gruvel [1] a souligné la présence en Méditerranée orientale d'espèces « lessepsiennes » en provenance de Mer Rouge, mais ne mentionne pas l'influence de ces espèces d'affinité chaude. Probablement, le rôle de ces espèces dans la structuration des biocénoses indigènes (surtout benthiques) n'était pas encore significatif. En vue des connaissances progressives des habitats marins, la côte Levantine et en particulier celle du Liban représente un domaine intéressant d'étudier les changements biotiques liés à la «tropicalisation» de la Méditerranée et aux espèces introduites qui ont augmenté au dépens des espèces indigènes [2].

Matériel et méthodes Depuis 1991, nous avons prospecté systématiquement la côte libanaise en plongée, en effectuant des relevés visuels et en prélevant des échantillons. Plusieurs campagnes de plongées intensives inspirées par la même motivation (faire progresser l'inventaire de la biodiversité, relever les incidences des activités humaines et en particulier l'impact des espèces exotiques) ont eu lieu dans le cadre de la coopération libano-française et libano-espagnole. La reconnaissance visuelle immédiate des communautés a été complétée par des photographies sous-marines et par prélèvements d'organismes, entre les hauts niveaux et 67 m de profondeur.

Etat des lieux Le changement climatique en Méditerranée est un fait incontestable. Des séries d'enregistrements de température à long terme ont démontré pour la Méditerranée Nord Occidentale une tendance au réchauffement de l'ordre de 1°C. De même des événements extrêmes comme ceux des étés 1999 et 2003 ont aboutit à des mortalités massives d'invertébrés de substrats durs [3]. Au Liban, les études de l'impact du changement climatique sur la vulnérabilité des écosystèmes marins sont peu nombreuses et fragmentaires. Des séries temporelles de 4 ans (1999 à 2002) ont montré des différences interannuelles ainsi qu'un changement de niveau de la thermocline [4]. L'impact du changement global en Méditerranée orientale est plus ancien qu'en Méditerranée occidentale vu que le régime thermique y est beaucoup plus élevé. On a souligné, Il y a 45 ans, une fréquence élevée des espèces à affinité chaude dans le bassin levantin sans mentionner l'influence des espèces exotiques de la Mer Rouge [5]. Probablement, le rôle de ces espèces dans la structuration des biocénoses de la Méditerranée n'était pas encore significatif. Dans les parties les plus chaudes de Méditerranée comme la côte libanaise, les altérations des écosystèmes, les mortalités et la disparition des espèces sensibles au réchauffement se sont produites il y a longtemps. Les gorgones qui ont été signalées au Liban il y a plus de 75 ans [1], ne sont plus citées dans la littérature au moins dans les 60 premières mètres. La moule *Mytilus galloprovincialis* est remplacée par l'espèce exotique *Brachidontes pharaonis*. L'herbier *Posidonia oceanica* n'est plus vu au Liban depuis 1977 (observations personnelles). Cet herbier est remplacé par les herbiers de *Cymodocea nodosa* et *Halophila stipulacea*. Pour les poissons herbivores, les deux espèces lessepsiennes *Siganus rivulatus* et *S. luridus* sont en cours de remplacer le poisson local *Sarpa salpa*. Le crabe *Charybdis helleri* devient de plus en plus abondant aux dépens des *Eriphia verrucosa, Pilumnus hirtellus* et *Pachygrapsus marmoratus.* L'arrivée des espèces exotiques est due en grande partie à la tropicalisation et à leur capacité de résistance plus importante que celle des espèces indigènes sans oublier la place disponible. Actuellement, parmi plus de 25 principaux habitats (de la surface jusqu'à 45 m), il y en a 18 qui sont formés d'espèces exotiques dont 4 (soulignées) sont envahissantes: *Brachidontes pharaonis, Pomatoleios kraussii, Caulerpa scalpelliformis, Ganonema farinosum, Macrorhynchia philippina, Oculina patagonica, Cerithium scabridum, Phallusia nigra, Spondylus spinosus, Chama pacifica, Herdmania momus, Galaxaura rugosa, Stypopodium schimperi, Caulerpa racemosa var. lamourouxii, Codium taylorii, Halophila stipulacea,Strombus decorus* et *Codium sp.* groupe *repens* [2, 6 et observations personnelles]. La capacité de résistance des espèces exotiques est expliquée par leur pouvoir de s'installer en mer, à des profondeurs différentes (y compris les ports, les grottes et les salissures), aussi bien dans les zones propres et polluées (e.g. *C. pacifica, S. spinosus, Pinctada radiata, S. decorus, P. Kraussii, Synaptula reciprocans, P. nigra, H. momus, Symplegma brakenhielmi et C. helleri*). Le réchauffement d'origine anthropique peut avoir des affections et des conséquences visibles sur les écosystèmes et sur les espèces aussi bien indigènes et exotiques. C'est le cas du blanchissement et parfois la disparition dans plusieurs localités libanaises des coraux *Oculina patagonica*. Plusieurs espèces et certains écosystèmes sont souvent déjà fragilisés par les pollutions et/ou la surexploitation et la fragmentation des habitats. Ils peuvent ainsi présenter une très grande sensibilité à un changement du climat. C'est le cas des espèces menacées qui deviennent de plus en plus rares : *Hippospongia communis, Spongia spp., Charonia lampas, Charonia tritonis variegata, Tonna galea, Stramonita haemastoma, Pinna nobilis, Sabella spallanzanii,* et *Cystoseira amentacea*. Il convient de rappeler que certaines conséquences des changements climatiques et de l'expansion des espèces envahissantes seront irréversibles, et que, dans certains de ces cas, il n'existe donc pas de réduction de la vulnérabilité. C'est là un risque important tout particulièrement pour la biodiversité marine. On est donc en train d'assister à un bouleversement de la géographie du climat et des biocénoses en Méditerranée et en particulier dans sa partie levantine, conditionnant des déplacements dans l'espace des espèces leur permettant de se maintenir dans des conditions environnementales propices à leur croissance et leur reproduction. A titre d'exemple les poissons *Thalassoma pavo* et *Diplodus cervinus cervinus qui* sont devenus communs en Méditerranée nord occidentale [3].

Conclusion et perspectives Le fait que le réchauffement global et l'arrivée des espèces exotiques affectent le bassin levantin en général et la côte libanaise en particulier et contribuent à des changements biotique et bionomique, il est nécessaire d'élaborer des plans d'action nationaux et régionaux afin de bien contrôler et suivre la répartition de ces espèces en relation avec le réchauffement global. Une évaluation complète de la vulnérabilité de la côte et des écosystèmes marins ainsi que des études sur les mesures d'adaptation sont nécessaires pour faire face à l'impact du changement de climat. Les séries temporelles de la température, doivent être poursuivies dans le temps et sur une longue période pour qu'ils s'intègrent dans le cadre du changement climatique et par suite des scénarios de projection. En ce sens, la côte libanaise représente un biotope intéressant pour étudier les changements liés à la "tropicalisation" de la Méditerranée et aux espèces exotiques (introduites ou migratrices à travers le Canal de Suez) surtout que les connaissances des communautés benthiques et ichthyologiques ont progressivement augmenté.

References
1 - Gruvel A., 1931. Les Etats de Syrie. Richesses marines et pluviales. *Soc. Edit. Géogr. Marit. et Colon.*, Paris, 453p.

2 - Bitar G., Ocana O., & Ramos-Espla A., 2007. Contribution of the Red sea alien species to structuring some benthic biocenosis in the Lebanon coast (Eastern Mediterranean). *Rapp. Comm. Intern. Mer Médit.*, 38, p. 437.

3 - Pérez T., 2008. Impact des changements climatiques sur la biodiversité marine et côtière en Méditerrranée. UNEP-MAP-CAR/ASP (N° 27/2007/RAC/SPA), Tunis : 58 p.

4 - Abboud-Abi Saab M., Romano J.C., Bensoussan N., Fakhri M., 2004. Suivis temporels comparés de la structure thermique d'eaux côtières libanaises (Batroun) et françaises (Marseille) entre juin 1999 et octobre 2002. *C.R. Geoscience* 336 : 1379-1390.

5 - Pérès, J.M., Picard, J. 1964. Nouveau manuel de bionomie benthique de la Mer Méditerranée. *Rec. Trav. St. Mar. Endoume*, 31(47): 1-133.

6 - Bitar G., Harmelin J.G., Verlaque M., Zibrowius H., 2000. Sur la flore marine benthique supposée lessepsienne de la côte libanaise. Cas particulier de *Stypopodium schimperi*. *Mednature* 1, RAC/SPA, PNUE: 97-100.

WASTE FLUXES DETERMINATIONS OF AN INTEGRATED MULTITROPHIC FISH FARM BY STABLE ISOTOPES (Δ13C AND Δ15N)

Andreu Blanco [1]*, Salud Deudero [2] and Jose maria Valencia [3]
[1] Laboratory of Biology and Physiology of Fish Larvae, Instituto de Investigaciones Marinas (CSIC) - andreublanco@iim.csic.es
[2] Centro Oceanográfico de Baleares, Instituto Español de Oceanografía
[3] Estación Aquicultura Andratx

Abstract
By analysing the isotopic composition of the cultured fish *Dentex dentex* and *Argyrosomus regius*, filter feeders and their food sources, it was demonstrated that unassimilated food sources could be reduced by using associated filter feeders in an integrative aquaculturemultitrophic method. This assessment has demonstrated a reduction of waste fluxes to the benthic compartment linked with the *Mytilos galloprovincialis* culture mixed with fish cages.
Keywords: Aquaculture, Balear Sea, Bivalves

Introduction
The rapidly increase of marine aquaculture to global sea food supplies implies changes in energy and nutrient fluxes of marine fish farming, impacting on benthic ecosystems by uneaten pellet food and faecal pellets (as the main components of particulate organic matter, POM) affecting habitats and communities such as the seagrass *Posidonia oceanica* (L.) communities [1]. A multitrophic system to reduce the impact of fish farm cages on the water and communities around cages is a possible solution, including primary sources of organic matter, filter feeders and consumers.

Materials and Methods
Fifteen cultivated specimens of *Dentex dentex* (Linnaeus, 1758), nine of *Argyrosomus regius* (Asso, 1801) and the bivalves *Mytilus galloprovincialis* (Lamarck 1869) and *Chlamys varia* (Linné 1758) were analysed to measure carbon and nitrogen isotope ratio and compared to the food sources supplied. Plankton and the particulated and sedimented organic matter were acidified by adding HCl 2N.

Results and Discussion
The comparision of the fish species and the filter feeders studied and their food sources was showed in figure 1. The percentage contribution of each source to each stable isotope composition (Mixing Models, Isosource, Fig. 2) indicates that filter feeders feds on fish farm wastes and presents some variability in the constancy at the bivalves, which could be related to the physiological and biochemical mechanisms occurring through the trophic increase in $d^{15}N$ values, and to food selectivity [2]. The additional potential input of organic matter into the system by the excretion of faeces and pseudofaeces associated to filter feeders would not have affected the water-column material neither sediment deposition, as it has been demonstrated [3] according to current velocities in the vicinities of the aquaculture station. Furthermore, it has been documented [4] that the association of *Mytilus galloprovincialis* with fish farm cages has a greatly profit from the aquaculture by the increasing mussel size and a reduction of the duration of the production cycle, which has been also demonstrated with the CI values of the bivalves of the present work.

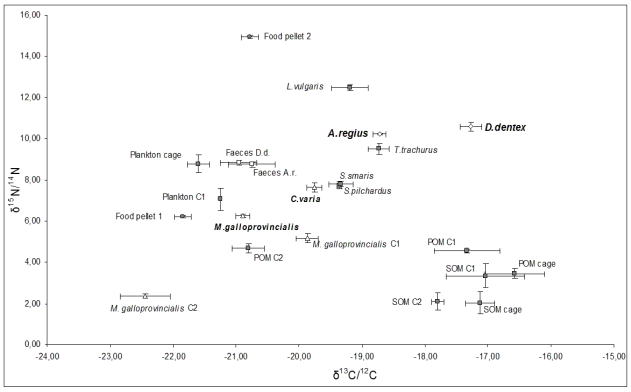


Fig. 1. Distribution of carbon and nitrogen stable isotope ratios (mean ± S.E.M.) among the different samples for organic matter fluxes. Food sources (grey squares), filter feeders and occasional species (white triangle), pellet food (grey circle) and cultured fish (white rhombus) are shown.

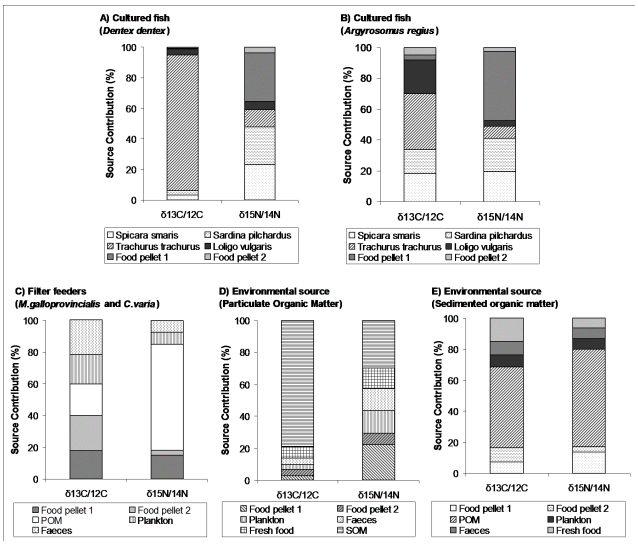


Fig. 2. Isosource analyses of the different compartments. Percentage contribution of the different sources to carbon and nitrogen stable isotopes for *Dentex dentex* (A), *Argyrosomus regius* (B), filter feeders (C) and POM (D).

References
1 - Holmer, M., Marba, N., Diaz-Almela, E., Duarte, C. M., Tsapakis, M.,Danovaro, R., 2007. Sedimentation of organic matter from fish farms in oligotrophic Mediterranean assessed through bulk and stable isotope ($d^{13}C$ and $d^{15}N$) analyses. *Aquaculture*, 262: 268-280.

2 - Lojen, S., Spanier, E., Tsemel, A., Katz, T., Eden, N., Angel, D. L., 2005. $d^{15}N$ as a natural tracer of particulate nitrogen effluents released from marine aquaculture. *Mar Biol*, 148: 87-96.

3 - Gibbs, M.T., 2007. Sustainability performance indicators for suspended bivalve aquaculture activities, *Ecol Indic*, 7: 94–107.

4 - Peharda, M., Župan, I., Bavcevic, L., Frankic, A., Klanjcek, T., 2007. Growth and condition index of mussel Mytilus galloprovincialis in experimental integrated aquaculture. *Aquacul Res*, 38: 1714-1720.

ISOTOPIC OFFSET BETWEEN MUSCLE AND SCALES OF THREE MEDITERRANEAN FISHES: *DENTEX DENTEX, ARGYROSOMUS REGIUS* AND *XYRICHTYS NOVACULA*, AT MARINE PROTECTED AREAS

Andreu Blanco [1]*, Salud Deudero [2] and Antonio Box [3]
[1] Laboratory of Biology and Physiology of Fish Larvae, Instituto de Investigaciones Marinas (CSIC) - andreublanco@iim.csic.es
[2] Centro Oceanográfico de Baleares, Instituto Español de Oceanografía
[3] Laboratorio Biologia Marina, Univesidad Illes Balears

Abstract
The present work test fish-scale sampling as a non-lethal technique for trophic level assessment instead of muscle isotopic determinations in fishes *Dentex dentex, Argyrosomus regius* and *Xyrichtys novacula*. The isotopic offset (Δ^{13}Cand Δ^{15}N) between muscle and scales indicate that the application of scales instead of muscle allow to apply non-lethal methods on isotopic studies regarding fish species for conservation purposes. This technique has been proven to be appropriate for trophic studies of fishes at marine protected areas

Keywords: Carbon, Food Webs, Trophic Relations

Introduction
Stomach content analysis provides information on recently ingested food sources while stable isotope analyses, particularly carbon and nitrogen, provides information on the long-term diets of organisms. Environmental conditions preserve chemical recording in animal tissues [1]. The analysis of different tissues gives the advantage of revealing the timescale needed to assimilate a new nutrient source [2]. Studies on fish tissue-diet isotope offset of endangered or protected fish species allows us to focus on conservation management.

Material and Methods
Fishes *Dentex dentex, Argyrosomus regius* and *Xyrichtys novacula* were selected owing to their wide distribution in Mediterranean waters, their economic importance and their value in the recreational fisheries of the Balearics. Isotopic composition (δ^{13}C and δ^{15}N) of white muscle and scales of *Dentex dentex, Argyrosomus regius* and *Xyrichtys novacula* are represented in Figure 1.

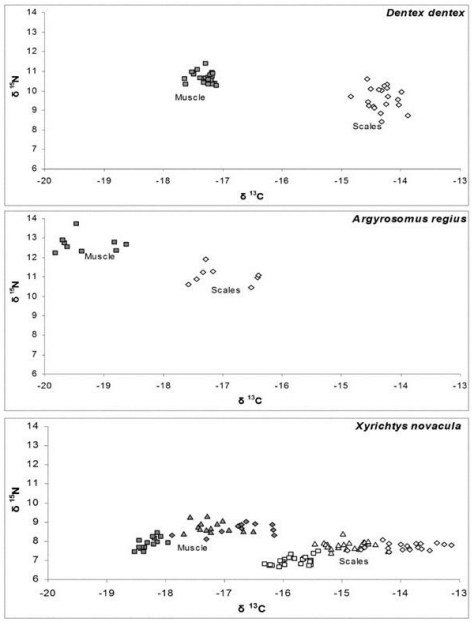


Fig. 1. Distribution of carbon and nitrogen stable isotope ratios (δ^{13}C and δ^{15}N) of farmed *Dentex dentex* (n = 20), farmed *Argyrosomus regius* (n = 9) and wild *Xyrichtys novacula* (n = 41), significant differences ($p < 0.001$) observed between tissues. Squares represent free-bone white muscle and rhombuses represent fish scales.

Results and Discussion
The present work shown significant correlation between stable isotope muscle tissue and scales signatures in *A. regius* ($p < 0.01$) and in *Xyrichtys novacula* ($p < 0.001$). No correlation was found in the muscle and scale stable isotope signatures of *Dentex dentex*. Nonetheless, all the species sampled showed significant differences between muscle and scale stable isotope (δ^{13}C and δ^{15}N) signatures (Paired t-test, $p < 0.01$). Tissue offset of ^{13}C and ^{15}N values derived from isotopic analyses of *D. dentex* did not varied significantly (Figure 2) and presented a constancy in the offset values (enriched 3.02 ± 0.06‰ for ^{13}C and depleted 0.91 ± 0.14‰ for ^{15}N). *A. regius* and *X. novacula* presented a linear regression (^{13}C enrichment of 2.27 ± 0.07‰ and 2.52 ± 0.04‰ and ^{15}N depletion of 1.69 ± 0.06‰ and 0.96 ± 0.03‰, respectively). The present work has yielded a correction factor for isotopic analyses that may be applied to marine fish species *Argyrosoums regius* and*Xyrichtys novacula*. The constancy in isotopic offset values of the farmed fish *Dentex dentex* (with a linear regression close to $R^2 = 0$; Figure 2) was related with the straight length values of the sampled individuals. Those results implie that lethal sampling is unnecessary, since other non-lethal tissues can provide a measure of the δ^{13}C and δ^{15}N signatures without affecting abundances by removing resources from the ecosystem or reducing their gene pools [3].

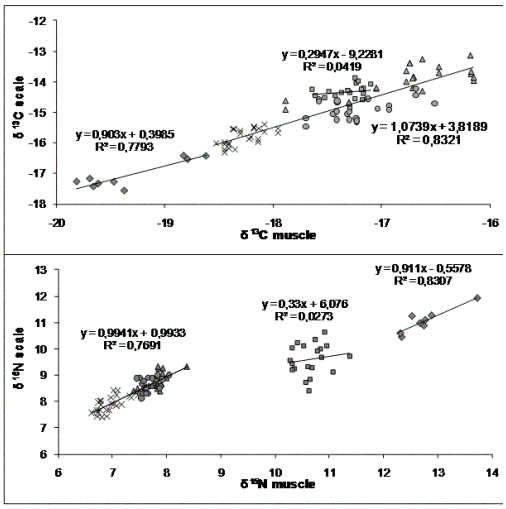


Fig. 2. Isotopic offset for δ^{13}C (A) and δ^{15}N (B) between free-bone white muscle and scales from *Dentex dentex, Argyrosomus regius* and *Xyrichtys novacula*

References
1 - Kennedy, B.P., Chamberlain, C.P., Blum, J.D., Nislow, K.H., Folt, C.L., 2005. Comparing naturally occurring stable isotopes of nitrogen, carbon, and strontium as markers for the rearing locations of Atlantic salmon (*Salmo salar*). *Can J Fish Aquat Sci*, 62: 48-57.
2 - Gaston, T.F., Suthers, I.M., 2004. Spatial variation in d^{13}C and d^{15}N of liver, muscle and bone in a rocky reef planktivorous fish: the relative contribution of sewage. *J Exp Mar Biol Ecol*, 304: 17-33.
3 - Kelly, M.H., Hagar, W.G., Jardine, T.D., Cunjak, R.A., 2006. Nonlethal Sampling of Sunfish and Slimy Sculpin for Stable Isotope Analysis: How Scale and Fin Tissue Compare with Muscle Tissue. N Am J Fish Manage, 26.

CHANGES IN THE CILIATE COMMUNITY OF EUTROPHICATED VRANJIC BASIN (MIDDLE ADRIATIC SEA) DURING 2004-2005

Natalia Bojanic [1]* and Olja Vidjak [1]
[1] Institute of Oceanography and Fisheries - Split - bojanic@izor.hr

Abstract
Temporal variability in ciliate abundances was investigated in eutrophicated Vranjic Basin (middle Adriatic), before and after activation of new sewage system. The differences were evident in the absence of nonloricate summer peak and reduction of average nonloricate and tintinnid abundances in 2005, 2.3 and 1.9 times, respectively. The distinction in tintinnid taxonomical composition between years was not noticed.
Keywords: Adriatic Sea, Density, Eutrophication, Zooplankton

The effects of eutrophication in the Kaštela Bay, primarily in the phytoplankton community, were first observed at the end of seventies. Since the end of 1980, summer "red tide" blooms have occurred regularly [1], causing occasional mortalities to shellfish and demersal fish. These biological changes were accompanied by oxygen supersaturation in the surface and hypoxia in the bottom layers. After the activation of modern sewage system in November 2004, disappearance of nutrient and oxygen extremes, decrease in bacterial and phytoplankton abundance and production, and re-establishment of the phytoplankton regular seasonal cycle were recorded [2].

In the Vranjic Basin the ciliates are an important zooplankton fraction, characterised by high biomass and intensive population dynamics [3]. As a result of their short generation time, they respond almost instantaneously to various environmental fluctuations and can act as stabilizers of the water-column community [4]. Therefore the aim of this study was to investigate possible changes in nonloricate (NLC) and tintinnid (TIN) assemblages after the activation of new sewage system.

Monthly samples were collected at one station located in the Vranjic Basin (43° 31.9'N; 16°27.2'E) in the middle Adriatic Sea, from January 2004 until November 2005, at 5 m depth intervals between the surface and bottom (15 m), using 5 l Niskin bottles. The plankton material was preserved and prepared for microscopic analysis as described in the reference [3].

Average column ciliate density values in the Vranjic Basin in 2004 ranged from 404±131 (December) to 2510±1638 ind.L^{-1} (May), while the oscillations in 2005 decreased by the factor 2.2, ranging from 75±54 (January) to 829±249 (September). Temporal variability was primarily due to changes in NLC community (r=0.95; p<0.0001; N=67), representing 34.0-96.4% of the total ciliate abundance.

The most prominent feature of NLC seasonal dynamics was the occurrence of three peaks in 2004, and two in 2005 (figure 1). Unlike the spring and autumn increases recorded in both years, the summer maximum was not found in 2005. During the whole investigated period, the highest average abundance values of 1545±1350 and 575±283 ind.L^{-1} were recorded in May, while autumn maxima were somewhat less pronounced. Apart from the high TIN abundances recorded in spring 2004, with the average column values of 966±593 ind.L^{-1} in May, TIN concentrations did not vary significantly during the rest of sampling period (figure 1).

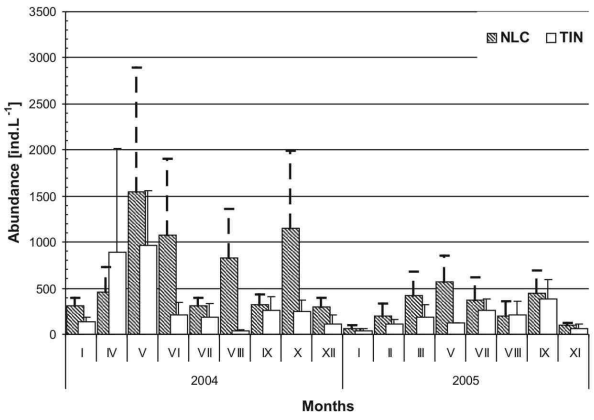


Fig. 1. Seasonal distribution of ciliates in the Vranjic Basin during the 2004-2005 (NLC, nonloricate ciliates; TIN, tintinnids)

In both sampling years the NLC vertical distribution was characterised by quite homogenous distribution during the isothermal conditions. However, temperature stratification caused the redistribution of NLC, with the maximum in surface layers, particularly in May 2004 (3389 ind-L^{-1} at 0 m). The exception was noted only in October 2004, when majority of NLC migrated to 10 m depth (2176 ind-L^{-1}). Apart from the hydrographical properties of the Basin, vertical distribution of TIN was related to their taxonomical structure. Among 44 determinated TIN species, statistical analysis extracted *Favella ehrenbergii*, *Codonellopsis schabi*, *Tintinnopsis beroidea* and *Helicostomella subulata* as discriminator species that contributed to dissimilarities between the sampling years with 23.4%.

Although the differences in ciliate abundances between 2004 and 2005 were not significant (p=0.0592), the distinction was clearly evident in the absence of NLC summer peak and reduction of average NLC and TIN abundances in 2005, 2.3 and 1.9 times, respectively [3, 5]. The differences in TIN taxonomical composition between years were not evident.

Future long-term investigations of the trophic relationships within microbial food web and interactions with abiotic environmental factors are needed for better explanation and understanding of ciliate role in this eutrophic marine ecosystem.

References
1 - Marasovic I., Gacic M., Kovacevic V., Krstulovic N., Kušpilic G., Pucher-Petkovic T., Odžak N. and Šolic M., 1991. Development of the red tide in the Kaštela Bay (Adriatic Sea). *Mar. Chem*., 32: 375-385.

2 - Kušpilic G., Marasovic I., Krstulovic N., Šolic M., Nincevic-Gladan Ž., Bojanic N., Vidjak O. and Matijevic S., (in press). Restoration potential of eutrophic waters adjacent to large coastal cities: Lessons from the coastal zone of Croatia. *In*: CIESM Workshop Monographs.

3 - Bojanic N, Šolic M., Krstulovic N., Šestanovic S., Marasivic I. and Nincevic Ž., 2005. Temporal variability in abundance and biomass of ciliates and copepods in the eutrophicated part of Kaštela Bay (Middle Adriatic Sea). *Helgol. Mar. Res*., 59: 107-120.

4 - Capriulo G.M. and Carpenter E.J., 1980. Grazing by 35 to 202 µm microzooplankton in the Long Sound. *Mar. Biol*., 56: 319-326.

5 - Vidjak O., Bojanic N., Kušpilic G., Marasovic I., Nincevic Gladan Ž. and Brautovic I., 2006. Annual variability and trophic relations of the mesozooplankton community in the eutrophicated coastal area (Vranjic Basin, eastern Adriatic Sea). *J. Mar. Biol. Ass. U.K.*, 86: 19-26.

ON THE PRESENCE OF *CLAVELLA STELLATA* (COPEPODA:LERNAEOPODIDAE) (KROYER 1838) IN THE EUROPEAN HAKE (*MERLUCCIUS MERLUCCIUS*) (L.1758)

R. Bonfiglio [1], G. Gaglio [2], T. Bottari [3], P. Rinelli [3]*, G. Rapisarda [2] and F. Marino [2]

[1] Dipartimento di Sanità Pubblica Veterinaria, Univesità di Messina,polo Universitario Annunziata,98168,Messina (Italy)

[2] Istituto per l'Ambiente Marino Costiero, CNR,Spianata S. Ranieri,86,98122 Messina (Italy) - paola.rinelli@iamc.cnr.it

[3] Dipartimento di Biologia Animale ed Ecologia Marina,Università di Messina ,Polo Universitario Papardo,Messina (Italy)

Abstract

The aim of the present study is to assess the presence of *Clavella stellata* in *Merluccius merluccius* from the southern Tyrrhenian Sea. 859 specimens of European hake, coming from two experimental trawl surveys, were examined for the occurence of copepods. *Clavella stellata* was found in the buccal cavity (76) and gills (2) of 78/859 (9.08%) of hakes.

Keywords: Fishes, Parasitism, Copepoda

Clavella stellata belonging to the Family Lernaeopodidae (Copepoda, Siphonostomatoida) is a poorly studied copepod. This family is characterized by a sharp sexual dimorphism. Adult females are attached by a permanent anchorage organ, the bulla. This is produced in the frontal region of the cephalotorax (1). Male lernaeopodids are dwarf, and they are usually attached to the females. Males die after copulation (2). The aim of the present study is to assess the presence of *C. stellata* in *Merluccius merluccius* from the southern Tyrrhenian Sea. Study area is situated in the southernmost part of the Tyrrhenian Sea. Two experimental trawl surveys were conducted in July and November 2003. A total of 859 fishes belonging to the species *M. merluccius* were caugth. Macroscopical exam was aimed at evaluating the presence of ectoparasites on the skin, buccal and gills cavities. 10 parasite specimens were fixed in 70% alcohol solution and clarified by lactophenol for optical microscopy study. Parasite identification followed Scott & Scott (3) and Kabata (4). A total of 78 out of 859 (9.08 %) specimens were parasitized, 76 in the buccal cavity and 2 in the gills (Table 1). Each of the infected fish showed only one parasite. The examined parasites, all female sex, showed morphologic features that, according by Scott & Scott (3) and Kabata (4), allowed to classify the copepods as *Clavella stellata* (Kroyer, 1838) sin. *Anchorella stellata* – Fam. Lernaeopodidae (Figure1) . As far as we know, *C. stellata* has been described in the same host in North Sea and Atlantic Ocean (4), but has never been reported in the Tyrrhenian Sea. Our study does represent the first report of this parasite in the European hake in this area. From the literature the elective site of *C. stellata* is along the rims of the host opercula, although some specimens can be found between the bases of pectoral fins and occasionally even on the top of the head (5). The bulla is not embedded in the host tissues, but rather glued to the surface of scales or to the skin (4). In our observations, parasites were never localized on the skin; In 76 individuals they were in the mouth and only in 2 subjects in the gills, with the bulla glued to the mucosa.

Tab. 1. Table 1. Number and percentage of infected hakes.

Samplings	Number of examined hakes	Number of infected hakes	Percentage of infected hakes
July 2003	96	16	16,67
November 2003	763	62	8,13
tot	859	78	9,08

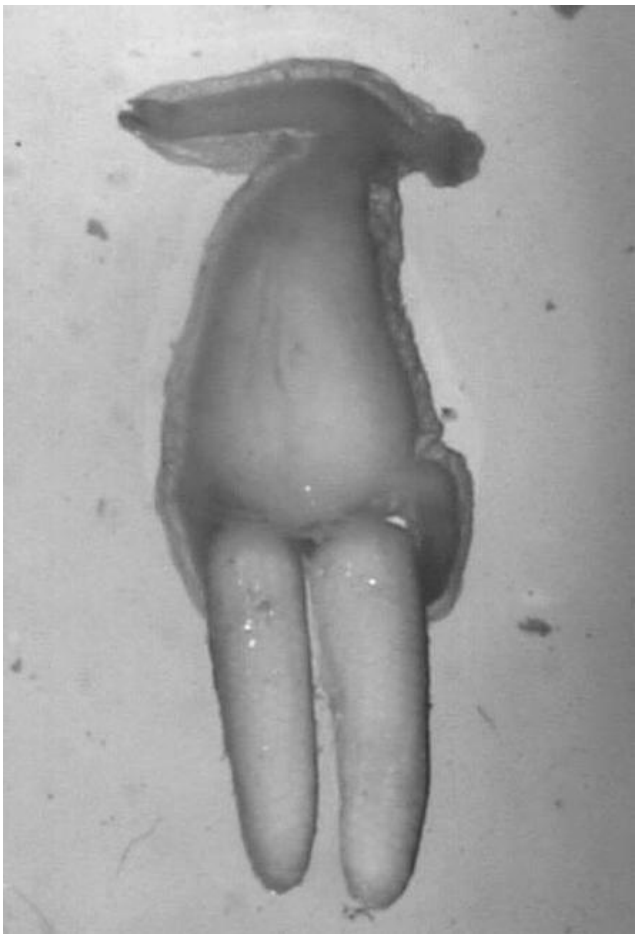


Fig. 1. Macroscopic image of *Clavella stellata*

References

1 - Lester R.J.G., Roubal F.R., 1999. Phylum Arthropoda, Copepoda: Lernaeopodidae In: Woo PTK (ed) Fish deseases and disorders: protozoan and metazoan infections, CAB International, Cambridge, pp 525-539.

2 - Kabata Z., Cousens B., 1973. Life cycle of *Salmincola californiensis* (Dana 1852) (Copepoda: Lernaeopodidae). J. *Fish. Res. Board Can. 30,881-903.*

3 - Scott, T., Scott, A., 1913. The British Parasitic Copepoda, vol. I, London.

4 - Kabata Z., 1992. Copepods parasitic on fishes. The Linnean Society of London and The Estuarine and Coastal Sciences Association, Universal Book Services, Dr W.Backhuys, Oegstgeest, The Netherlands.

5 - Benkirane O., Coste F., Raibaut A., 1999. On the morphological variability of the attachment organ of Lernaeopodidae (Copepoda: Siphonostomatoida). *Folia Parasit.* 46,67-75.

DECLINE OF THE *POSIDONIA OCEANICA* SEAGRASS MEADOW AT ITS LOWER LIMIT IN A PRISTINE MEDITERRANEAN LOCALITY

P. Bonhomme [1], D. Bonhomme [1], C. F. Boudouresque [2]*, G. Cadiou [1], E. Charbonnel [3] and S. Ruitton [2]
[1] Centre d'océanologie de Marseille, Université de la Méditerranée - charles.boudouresque@univmed.fr
[2] GIS posidonie, Université de la Méditerranée
[3] Parc marin de la Côte Bleue

Abstract
The lower limit (31-34 m deep) of the *Posidonia oceanica* meadow was monitored (2002 through 2008) at Port-Cros Island (Provence, France, Mediterranean Sea), a national park where the biota and communities are considered to be in pristine condition. Both shoot density and cover conspicuously declined at the seagrass limit.
Keywords: Posidonia, Monitoring, Phanerogams, Temperature

Introduction
Posidonia oceanica seagrass meadows are utilized as a biological indicator which allows an overall assessment of the quality of the marine environment and an evaluation of the efficiency of management policies. Within the Port-Cros Island national park (Provence, France, Mediterranean), biota and communities are considered to be in pristine condition. As a result, the *P. oceanica* lower limit is expected to be stable, in contrast with many other Mediterranean localities [1].

Material and Methods
Two sets of 10 cement markers were laid down at the lower limit of the *P. oceanica* meadow, i.e. at the boundary between the meadow and the dead matte or the coastal detritic community (sand) which extends downwards and offshore. The first monitoring site is localized near La Palud Cove (34 m deep), on the northern coast of Port-Cros Island. The second one is localized on the southeastern coast, between Pointe du Vaisseau and Pointe du Tuf (31-34 m deep). They were established in fall 2002 and 2006 respectively, and then monitored in fall 2005 and 2008. The *P. oceanica* shoot density was measured in the vicinity of each marker by means of a 20 cm x 20 cm frame randomly placed (three replicates). Shoots were counted within the frame. The cover is the mean percentage of substrate covered by the *P. oceanica* meadow (whatever the shoot density within the meadow or within patches of *P. oceanica*); cover was measured according to the method described by Boudouresque *et al.* [2].

Results and Discussion
The mean shoot density of the *Posidonia oceanica* meadow declined from 123 to 48 shoots/m² between 2002 and 2008 at La Palud (Wilcoxon signed-rank test, p= 0.005; Table 1), at a mean annual rate of reduction of 14%. The bottom cover declined at an annual rate of 7% at La Palud (2002-2008; p= 0.03; Table 2) and 20% at Vaisseau-Tuf (2006-2008; p= 0.01; Table 2). According to Pergent *et al.* (1995) these values fall within the range of "normal densities" for a pristine meadow at the depths considered (61-285 shoots/m² at 31 m depth, 38-262 at 34 m).

Tab. 1. Change over timeofshoot density (mean number of shoots per m^2) of the *P. oceanica* meadow.

Year	Shoot density near markers LP1-LP10. La Palud site										Mean
	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9	LP10	
2002	75	100	150	150	108	83	175	150	117	108	123
2005	42	92	104	67	42	40	115	110	67	83	76
2008	58	58	117	8	33	17	58	33	58	42	48
	Shoot density near markers VT1-VT10. Vaisseau-Tuf site										
	VT1	VT2	VT3	VT4	VT5	VT6	VT7	VT8	VT9	VT10	
2006	67	108	83	83	200	133	67	117	92	108	106
2008	67	100	92	67	125	142	67	125	108	133	103

Tab. 2. Change over time of bottom cover (%) of the *P. oceanica* meadow.

Year	Cover near markers LP1-LP10. La Palud site										Mean
	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9	LP10	
2002	41	35	28	22	17	15	26	19	19	24	24%
2005	24	30	17	24	22	17	17	19	31	11	21%
2008	15	19	11	19	11	15	19	22	26	11	17%
	Cover near markers VT1-VT10. Vaisseau-Tuf site										
	VT1	VT2	VT3	VT4	VT5	VT6	VT7	VT8	VT9	VT10	
2006	22	83	39	48	31	57	54	80	63	57	53%
2008	19	39	26	33	43	44	41	37	30	28	34%

The decline of shoot density constitutes a harbinger for the withdrawal of the seagrass meadow limit [3]. The steady retreat of most deep *P. oceanica* limits in the northwestern Mediterranean [3], including those of meadows in supposedly pristine localities, is a worrying feature, the cause of which is unclear.

References
1 - Boudouresque C.F., Bernard G., Pergent G., Shili A., Verlaque M., 2009. Regression of Mediterranean seagrasses caused by natural processes and anthropogenic disturbances and stress: a critical review. *Bot. mar*., 52: 395-418.
2 - Boudouresque C.F., Bernard G., Bonhomme P., Charbonnel E., Le Diréach L., Ruitton S., 2007. Monitoring methods for *Posidonia oceanica* seagrass meadows in Provence and the French Riviera. *Sci. Rep. Port-Cros natl. Park,* 22: 17-38.
3 - Mayot N., Boudouresque C.F., Charbonnel E., 2006. Changes over time of shoot density of the Mediterranean seagrass *Posidonia oceanica* at its depth limit. *Biol. Mar. Medit.*, 13 (4) : 250-254.

AGE AND GROWTH OF *CHELIDONICHTHYS LASTOVIZA* ((BONNATERRE, 1788) IN TUNISIA

L. Boudaya [1]*, L. Neifar [1], P. Rizzo [2], C. Badalucco [2], A. Bouain [1] and F. Fiorentino [2]
[1] National Council of Research Institute for Marine Coastal Environment , Mazara del Vallo, Italy
[2] FLaboratoire de Biodiversité et Ecosystèmes aquatiques, Faculté des Sciences de Sfax, Tunisia - l_boudaya@yahoo.fr

Abstract
A total of 768 specimens of *Chelidonichthys lastoviza* was collected from landings of bottom trawlers between January 2003 and November 2004. The total length ranged from 12 to 22 cm in females and from 13 to 19 cm in males. Marginal increment analysis of otoliths showed that the translucent zone was laid from November to April and the opaque zone laid from May to October. Females were from age group I to V and males from I to IV. Growth parameters of the von Bertalanffy growth function were $TL_\infty = 33$; $K = 0.13$ and $t_0 = -2.94$ in females and $TL_\infty = 29.84$; $K = 0.13$ and $t_0 = -3.73$ in males.
Keywords: Growth, Gulf Of Gabes

Introduction
Chelidonichthys lastoviza (Bonnaterre, 1788), together with *Chelidonichthys lucerna* (Linnaeus, 1758) and *Chelidonichthys obscurus* (Linnaeus, 1764), are the main gurnards landed by Tunisian fiheries. The present study aims to provide information on age and growth, of this species in the Gulf of Gabès (Southern Tunisia).

Materiel and methods
A total of 768 specimens of *C. lastoviza* were monthly sampled from January 2003 to November 2004 randomly from the landings of bottom trawlers operating in the Gulf of Gabès. Total length (TL) and total weight (TW) were measured to the nearest mm and 0.01g respectively. 674 Sagittal otoliths were read as whole. Opaque and transparent rings were counted and one opaque zone with one transparent zone considered as anual growth. Yerly increments are counted considering the tranlucent zones, which are considered to be laid down in winter. Growth was expressed through the "classic" model of Von Bertalanffy. Growth parameters were estimated by non – linear approach as implemented in the FISAT package [1]. For the sake of comparison, the index of overall growth performance φ' [2] was used.

Results and discussion
Marginal increment analysis showed that one opaque and one translucent zone were deposited annually. The translucent zone, corresponding to the period of slow growth, occurred from November to April while the opaque zone, corresponding to the period of fast growth, occurred from May to October. A similar pattern was common among other gurnard species [3,4]. The seasonal changes observed in the otolith margin maybe related to seasonal fluctuations in water temperature in the Gulf of Gabès [5]. Nevertheless, the pattern observed may reflect other environmental changes such as photoperiod and prey availability, in addition to internal physiological factors as suggested by Pannella (1980) [6]. Females ranged between 12 to 22cm TL and males between 13 and 19 cm TL. The age group in the exploited stock varied between I to IV (males) and V (females). Von Bertalanffy parameter estimates (table 1) showed that *C. lastoviza* is a relatively fast-growing and moderately long-living species, like other gurnads species (3). A comparison of male (2.06) and female (2.15) φ' values shows that the population of the Gulf of Gabès had a slow growth performance compared with other populations [7].

Tab. 1. Growth parameters of the Von Bertalanffy growth equation and the growth performance index (φ') for *C. lastoviza*.. (Lt: asymptotic total length; K: the growth curvature parameter; t_0: the theoretical age when total length of fish is zero)

Paramètres	Mâles	Femelles
LT	29.84	33.00
K	0.13	0.13
t0	-3.73	-2.94

References
1 - Gayanilo F. C. Jr. , Sparre P. and Pauly D., 1996. FAO-ICLARM stock assessment tools (FiSAT) user's manual. FAO computerized information Series (Fisheries) 8: 126.
2 - Pauly D.and Munro J. L., 1984. Once more on the comparison of growth in fish and invertebrates. ICLARM Fishbyte 2: 21p.
3 - Colloca F., Cardinale M. and Ardizzone G. D., 2003. Tracing the life history of red gurnard (*Aspitrigla cuculus*) using validated otolith annual rings. *J. Appl. Ichthyol*. 19:1-9.
4 - Boudaya L., Neifar L. Rizzo P., Badalucco C., Bouain A. and Fiorentino F., 2008. Growth and reproduction of *Chelidonichthys lucerna* (Linnaeus) (Pisces: Triglidae) in the Gulf of Gabes, Tunisia. *J. Appl. Ichthyol.* 24 : 581–588.
5 - Ktari-Chakroun F. and Azouz A., 1971: Les fonds chalutables de la région sud-est de la Tunisie (Golfe de Gabès). Bull. Inst. Océanogr. Pêche. Salambô 2: 5-48.
6 - Pannella G., 1980: Growth pattern in fish sagittae. *In*: Rhoads D.C, and Lutz R. A. (eds), Skeletal growth of aquatic organisms: biological records of environmental changes. Plenum press New York, pp. 519-556.
7 - Baron J., 1985. Les Triglides (Teleosteens, Scorpaeniformes) de la Baie de Douarnenez. I. La croissance de: *Eutrigla gurnardus, Trigla lucerna, Trigloporus lastoviza* et *Aspitrigla cuculus*. Cybium 9 : 127-144.

AGE, CROISSANCE ET REPRODUCTION DU BARRACUDA *SPHYRAENA VIRIDENSIS* (SPHYRAENIDAE) DES COTES DE L'EST ALGERIEN

Nadjette Bourehail [1]*, Raymonde Lecomte-Finiger [2] and Mohamed Hichem Kara [1]
[1] Laboratoire Bioressources marines, Université de Badji Mokhtar, Annaba, 23000, Algérie - nadjetteb@yahoo.fr
[2] UMR 5244 CNRS UPVD EPHE, Centre de Biologie et Ecologie Tropicale et Méditerranéenne, 66860 Perpignan, France

Abstract
L'âge, la croissance et la reproduction sont étudiés chez le grand Barracuda *Sphyraena viridensis* (Cuvier, 1829) des côtes Est de l'Algérie. Une clé âge taille et une clé âge poids sont présentées à partir d'un échantillonnage mené sur 683 individus pêchés dans le golfe d'Annaba. L'analyse des coupes des sagittae a révélé que les âges varient entre 0^+ et 9 années. Un dimorphisme sexuel se manifeste à partir de la quatrième année. La première maturité sexuelle est acquise à partir d'une longueur totale (Lt_{50}) de 62,5 cm chez les femelles et 59,5 cm chez les mâles.
Keywords: Algerian Basin, Fishes, Growth, Reproduction

Introduction
Sur les côtes algériennes, tous les inventaires réalisés depuis Dieuzeide *et al*. [1] indiquent que la famille des Sphyraenidés est représentée exclusivement par l'espèce *Sphyreana sphyraena*. Cependant, deux espèces du genre *Sphyraena* ont été identifiées dans le golfe d'Annaba, *Sphyraena sphyraena* et *Sphyraena viridensis* [2]. Nous présentons dans ce travail les premières données sur l'âge, la croissance et la reproduction du Barracuda *Sphyraena viridensis* des côtes de l'Est Algérien.

Matériel et méthodes
Au total, 683 individus de longueur comprise entre 18,4 cm à 113 cm, correspondant à des poids variant de 25,06 g à 6710 g ont été examinés. Ils ont été récoltés dans les poissonneries de la ville d'Annaba. La détermination de l'âge est réalisée par otolithométrie. La longueur totale correspondant à chaque âge est rétro calculée par la méthode de Lee [3]. Les croissances, linéaire et pondérale, sont ajustées au modèle de Von Bertalanffy [4]. La relation taille poids $W = aL^b$ [5] est établie par sexe et pour l'ensemble de la population. La sexualité et la reproduction sont analysées à l'aide du sex-ratio SR (% des mâles), du rapport gonosomatique (RGS) et du rapport hépatosomatique (RHS). La taille de maturité sexuelle, celle pour laquelle 50 % des individus sont adultes, est estimée.

Résultats et discussion
La figure 1 montre que la croissance linéaire est très rapide durant la première année. Son taux annuel diminue ensuite progressivement, surtout à partir de la troisième année, en raison probablement de l'acquisition de la première maturité sexuelle. Sur la base des observations et des mesures prises sur les coupes des otolithes *sagitta*, une forte corrélation a été déterminée entre le rayon total de l'otolithe et la longueur totale du poisson ($r = 0,87$, $p \leqslant 0,01$). L'équation décrivant la relation longueur totale du poisson (Lt en mm) en fonction de la longueur du grand rayon de l'otolithe (Rt en mm) est : $Lt = 272,33\ Rt - 5,51$. La méthode de retrocalcul a permis de définir neuf groupes d'âge dans la population totale, dont les plus représentés sont les groupes 1, 2 et 3.

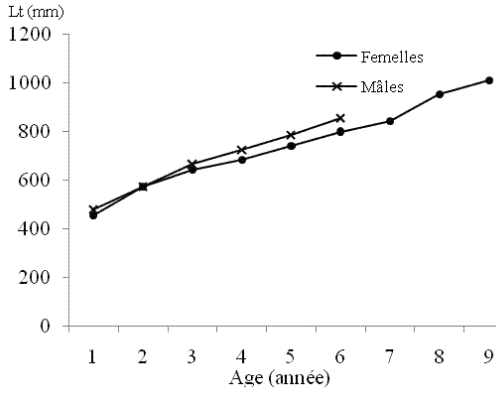


Fig. 1. Croissance linéaire absolue de *Sphyraena viridensis* (o : femelles, x : mâles) des côtes de l'Est de l'Algérie

Le coefficient d'allométrie de la relation entre la longueur totale et le poids total est exprimé par la relation : $Pt = 2,099.10^{-3}\ Lt^{3,131}$. La valeur du coefficient d'allométrie (b = 3,131) indique une allométrie de croissance majorante.
Le cycle du rapport gonado-somatique (RGS) fournit des indications sur la periode de ponte (Fig. 2). Le RGS atteint son maximum en avril chez les mâles (5,606) comme chez les femelles (4,941). Cette espèce est gonochorique, l'évolution temporelle de son sex-ratio montre une dominance des femelles.

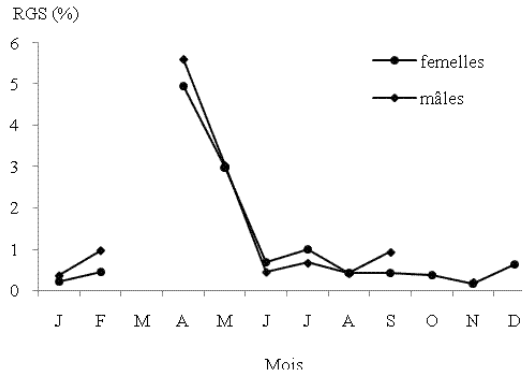


Fig. 2. Evolution mensuelle du RGS chez les femelles et les mâles de Barracuda *Sphyraena viridensis* des côtes de l'Est de l'Algérie

Les tailles de maturité sexuelle sont estimées à partir des observations réalisées en pleine saison de maturation des gonades (avril - juillet). Les individus, répartis par classe de 10 mm, sont supposés tous adultes à partir de 625 mm pour les femelles, de la classe 595 pour les mâles.

References
1 - Dieuzeide R., Novella M. & Roland J., 1954. Catalogue des poissons des côtes algériennes II.
2 - Kara M. H. & Bourehail N., 2003. Présence du Barracuda, *Sphyraena viridensis* (Sphyraenidés), sur les côtes de l'Est algérien. *Cybium* 2003, 27(1): 59-60.
3 - Lee, R.M., 1912. A review of the methods of age and growth determination in fish by means ofscales. Fisheries Fish Inves. London, 2(4): 32 p.
4 - Bertalanffy L. Von, 1938. A quantitative theory of organic growth. *Hum.Bioi*, 10(2): 181-213.
5 - Teissier, G., 1948. La relation d'allométrie: sa signification statistique et biologique. *Biometrics*, 4(1): 14-53.

SEASONAL VARIATION IN THE FATTY ACID COMPOSITION OF ATHERINA SP FROM KERKENNAH ISLANDS

Nawzet Bouriga [1]*, Salah Selmi [2], Eric Faure [3] and Monia Trabelsi [4]

[1] Faculté des Sciences de Tunis. Unité de Biologie Marine. Manar II, 2092 Campus universitaire. Tunisie. LATP, CNRS-UMR 6632, Evolution biologique et modélisation, case 5, Université de Provence, Place Victor Hugo, 13331 Marseille cedex 3, France - hanounawsset@live.fr

[2] Institut National des Sciences et Technologies de la Mer INSTM, La Goulette 2060, Tunisie.

[3] LATP, CNRS-UMR 6632, Evolution biologique et modélisation, case 5, Université de Provence, Place Victor Hugo, 13331 Marseille cedex 3, France

[4] Faculté des Sciences de Tunis. Unité de Biologie Marine. Manar II, 2092 Campus universitaire. Tunisie.

Abstract

The effects of seasonal variations on the fatty acid composition of the silverside *Atherina sp* from Kerkennah islands were determined for a one-year period. The levels of lipid displayed pronounced seasonal fluctuations with the highest values in March. The increase of the polyunsaturated fatty acids (PUFA) percentage was accompanied with a decrease of saturated fatty acids. Docosahexaenoic acid and eicosapentaenoic acid were the most abundant PUFA. The percentages of total n-3 fatty acids were higher than those of total n-6 fatty acids in spring season.

Keywords: Fishes, Islands, Chemical Analysis

Introduction

Atherina is a genus of small inshore fishes with many populations living in brackish, marine water and fresh water [1]. Like marine food products, Silverside are valuable sources of nutrients such as lipids. Lipids of marine fish are rich in n-3 long chain polyunsaturated fatty acids [2], [3], [4] of excellent nutritional value and beneficial effect on human health, especially eicosapentaenoic acid (C20:5n-3) and docosahexaenoic acid (C22:6n-3). *Atherina sp* is one of the commercially important and highly consumed fish species in Tunisia especially in the centre and south coast of Tunisia. In view of these facts, the aim of this study was to determine seasonal variations of the fatty acid composition and n-3/n-6 ratios of the Silverside which has not been studied in the area. Materials and methods This study was carried out in 2008 and samples were obtained in January, March, May, July, September and November from kerkennah islands (Tunisia). This study was focused on adult fishes and samples were conserved at -40°C until their analysis. Total lipids were extracted according to [5] procedures by chloroform/methanol (2/1) and quantified gravimetrically. A fraction of lipids extract was transesterificated according to the experimental procedure of [6]. The comparison of different biochemical parameters were tested using Duncan's test (95% confidence interval) with one-way ANOVA.

Results and discussion

The fat content of the analysed specie shows an important dependency on season (Table 1) in Silverside, it was minimal in September and November (2.4–2.2%), and maximal in March and May (4.7%–5.9%). The fatty acid profile in silverside was typical of marine animals (Table2), with the dominance of palmitic acid (C16:0) for saturated fatty acids SFA. Also, Oleic acid (C18:1) was identified as the major monounsaturated fatty acids MUFA, Docosahexaenoic acid (DHA) (C22:6n-3), linoleic acid (LA) (C18:3) and eicosapentaenoic acid (EPA) (C20:5n-3) were the most abundant polyunsaturated fatty acids PUFA. The same data were found by [7], [8]. In the present study, the significant increase ($p < 0.05$) of the polyunsaturated fatty acids percentage was accompanied with a decrease of saturated fatty acids. The observed increase in PUFA is likely due to the preparation of spawning period. This finding is supported by the fact that the level of PUFA was lowest both before and just after reproduction [9]. The n-3/n-6 ratio is a good index for comparing relative nutritional value of fish oils [10]. The present data show that in all months except September and November, the percentages of total n-3 fatty acids were higher than those of total w6 fatty acids. n-3/ n-6 fatty acids ratio in Silverside can be significantly influenced by spawning and season.

Conclusion

This study has shown that the maximum levels of lipids were reached during the period of March and May; in contrast, the lowest levels were recorded in September and November. The Silverside is a suitable item in the human diet during the spring period in Kerkennah islands when the levels of EPA, DHA and n-3/n-6 ratio are considered.

References

1 - Quignard J.P. and Pras A., 1986. Atherinidae. In Whitehead P.J.P. Bauchot M.L., Hureau J.C., Nielsen J., Tortonese E., (eds) Fishes of the North-eastern Atlantic and the Mediterranean. Vol. 3., UNESCO, Paris, p 1207-1210.

2 - Osman N.H., Suriah A.R. and Law E.C., 2001. Fatty acid composition and cholesterol content of selected marine fish in Malaysian waters. *Food Chemistry*., 73: 55–60.

3 - Aidos I., Van Der Padt A., Luten J.B. and Boom R.M., 2002. Seasonal Changes in Crude and Lipid Composition of Herring Fillets, By-products, and Respective Produced Oils. *Journal of Agricultural and Food Chemistry*., 16: 4589-4599.

4 - Passi S., Cataudella S., Di Marco P., De Simone F. and Rastrelli L., 2002. Fatty Acid Composition and Antioxidant Levels in Muscle Tissue of Different Mediterranean Marine Species of Fish and Shellfish. *Journal of Agriculture and Food Chemistry*., 50: 7314-7322.

5 - Folch J., Lees M. and Stanley G.H.S., 1957. A simple method for the isolation and purification of total lipids from animal tissue. *Journal of Biological Chemistry*., 226: 497-509.

6 - Metcalfe L.D., Schimitz A.A., and Pelka J.R., 1966. Rapid preparation of fatty acids esters from lipids for gas chromatographic analysis. *Annexe Chemistry*., 38: 524-535.

7 - Pirini M., Gatta P.P., Testi S., Trigari G., and Monetti P.G., 2000. Effect of refrigerated storage on muscle lipid quality of sea bass (Dicentrarchus labrax) fed on diets containing different levels of vitamin *E. Food Chem*., 68: 289–293.

8 - Surh J., Ryu J.S. and Kwon H., 2003. Seasonal Variations of Fatty Acid Compositions in Various Korean Shellfish. *J. Agric. Food Chem*., 51: 1617–1622.

9 - Cejas J.R., Almansa E., Villamandos J.E., Badia P., Bolanos A., and Lorenzo A., 2003. Lipid and fatty acid composition of ovaries from wild fish and ovaries and eggs from captive fish of white sea bream (Diplodus sargus). *Aquaculture.*, 216: 299–313.

CHARACTERISATION AND SEASONAL VARIATION OF LIPID AND FATTY ACID COMPOSITION OF COQUINA CLAM, *DONAX TRUNCULUS* (MOLLUSCA, BIVALVIA) FROM THE GULF OF TUNIS

D. Boussoufa [1]*, N. Ghazali [1], K. Telahigue [1], I. Chetoui [1], I. Rabeh [1], E. Viciano [2], J. C. Navarro [2] and M. El cafsi [1]
[1] Unité de Physiologie et d'Ecophysiologie des Organismes Aquatiques, Faculté des Sciences de Tunis - d.boussoufa@yahoo.fr
[2] Instituto de Acuicultura de Torre de la Sal (CSIC), 12595 Ribera de Cabanes, Castellón, España

Abstract
The lipid content and fatty acid composition of the coquina clam *Donax trunculus* (Mollusca, bivalvia) sampled from the sandy beach of Borj Cedria (BC) situated in the Gulf of Tunis (the North Eastern coast of Tunisia) were analysed. Total lipid content in dry weight was ranged from 4.8 to 7.3 % and the major fatty acids in *D. trunculus* tissues were palmitic (C16:0), stearic (C18:0), eicosapentaenoic (EPA) (C20:5n-3) and docosahexaenoic (DHA) (C22:6n-3) acids. In comparison with saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA) constituted the highest proportion during the four seasons.
Keywords: Bivalves, Physiology

Introduction
Donax trunculus (Linnaeus 1758) (Mollusca: Bivalvia) is an Atlantic-Mediterranean warm-temperate species. Among bivalves, it is one of the most harvested clams in the world [1]. Generally, gametogenesis takes place during winter and spring and gamete emission starts in late spring and continues until summer. In Tunisia, *D. trunculus* shows a large distribution with high density along the sandy beaches especially in the Gulf of Tunis coasts. To the best of our knowledge, informations concerning the quality requisites of *D. trunculus* in lipid and fatty acid composition do not exist. Therefore, the purpose of this work is to study the natural seasonal variations in lipids and fatty acid composition of *D. trunculus*.

Materials and methods
Specimens of *D. trunculus* were collected at approximately monthly intervals between July 2004 and may 2005 along the sandy beach of Borj Cedria at a depth of 50 cm. Total lipid from each sample (six replicates of the whole animal per season) was extracted with chloroform: methanol (2:1, v/v) [3]. Fatty acids from total lipids were acid catalysed transmethylated [4] and subsequently analysed by high resolution gas chromatography. Tukey Honest Significant Differences (HSD) multiple comparisons test was conducted to determine differences at a significance level of 5 % ($p<0.05$).

Results and Discussion
Total lipid content in dry weight of Donax tissues was accumulated especially during winter (7.37 %) and summer (5.9 %). The variation of lipid content could be explained by the abundance and quality of the available food in the Donax environment and by the accumulation or utilization of lipid reserves prior to gametogenesis.
Results on seasonal variations of the fatty acid composition ,expressed in percent of total fatty acids, (Table 1) indicate that the major fatty acids in D. trunculus tissues were C16:0, C18:0, C20:5n-3 and C22:6n-3 acids. Compared with SFA and MUFA, PUFA constituted the highest proportion. PUFA were generally low during summer (38.7 ± 2.2%), and high during winter (46 ± 2.2 %, p= 0.00019). SFA varied between 28.8 ± 1.9 % and 34.7 ± 2.4% respectively during winter and summer. No significant seasonal changes were observed in MUFA which represent the lowest proportion of total fatty acids. The seasonal variations of PUFA could hardly be correlated with the different phases of the annual reproductive cycle of the animals; this may explain the main function of these fatty acids in gamete formation. During the period under study, *D. trunculus* was characterised by high levels of n-3 PUFA (24.5-34.9 %), important in the human diet especially for their prevention of cardiovascular diseases, low levels of n-6 PUFA (6.4-9.7 %) and relatively high n-3/n-6 PUFA ratio values (3.5-5.6).
Due to their low lipid and the high percentage of healthy n-3 PUFA especially in winter and spring, periods of reserve accumulation, we can conclude that *D. trunculus* can be considered as a food item with interesting dietetic properties.

Tab. 1. Seasonal variations in lipid (g/100g dry weight) and fatty acid composition (% of total fatty acids) (means ± standard deviation) in the total mass of *Donax trunculus*

Fatty acids	Summer	Autumn	Winter	Spring
SFA	34.7±2.4	31.6±1.1	28.8±1.9	29.6±0.6
MUFA	16.8±2.3	17.2±5.2	13±2.2	15.5±2.1
PUFA	38.7±2.2	41.8±1	46±2.2	46.1±1.2
PUFAn-3	25.9±0.7	24.5±1.5	33±1.5	34.9±1.4
PUFAn-6	8.0±1.2	9.7±0.6	7.1±0.5	6.4±0.4
Lipids	5.9±1.4	4.8±0.9	7.3±2.1	4.9±1.9
n-3/n-6	3.5±0.7	3.7±1	4.8±1.5	5.6±0.6

References
1 - Özden Ö., Erkan N. and Cengiz Deval M., 2009. Trace mineral profiles of the bivalve species Chamelea gallina and Donax trunculus. *Food Chem.*, 113: 222-226.
2 - Walne P.R., 1976. Experiments on the culture in the sea of the butterfish Venerupis decussata L. *Aquaculture*, 8: 371-381.
3 - Folch J., Less M. And Sloane-Stanley C.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem.*, 266: 497-509.
4 - Christie W.W., 1982. Lipid Analyses, 2nd Ed. Oxford, PA: Pergamon Press, 207p.

TUNISIAN FISH FAUNA AND THE GLOBAL WARMING

Mohamed nejmeddine Bradai [1]*
[1] Institut National des Sciences et Technologies de la Mer (INSTM) - mednejmeddine.bradai@instm.rnrt.tn

Abstract
In Tunisia, 356 species of fish were reported between 1884 and 2009, some for the first time in this work. After a critical review, we eliminated six species mentioned in the ichthyologic literature. Two others seem dubious but also require a review. They are not considered in this work. Analysis confirms the subtropical character of Tunisia fish fauna and especially of the Gulf of Gabes and that this character is accentuating.
Keywords: Biogeography, Fishes, Gulf Of Gabes, Global Change

Introduction
This work updates the Tunisian fish species inventory [1]. It is based on the new records of species for the Tunisian waters available in the bibliography (after 2002) and on news observations made during surveying campaigns and visits to the main landing points.

Material and methods
A grouping of the recorded fish species is given according to their geographic distribution [2] into: (1) Cosmopolitan (2) Atlanto-Mediterranean (3) Endemic (4) Indo-Pacific. The following categorisation of the recorded species is also given: species mainly distributed in cold and temperate waters and species having affinity for tropical and subtropical waters [2].

Results and discussion
According to the data available in 2009, Tunisian fish biodiversity can be summarized as follows: Petromyzontiformes 1 species, Holocephali 1, Elasmobranchii 63, Chondrostei 1, Osteichthyes 282 for a total of 348 valid species belonging to 115 families, 229 genus and 30 Orders. Most species (294 of 348) have an Atlantic origin, 16 species are considered as sub-cosmopolitan and 25 are endemic to the Mediterranean. The Tunisian coasts are concerned by marine invaders originating from the tropical Atlantic (8 species) and Indo-pacific areas (13 species) (fig.1). Species coming from the northern Atlantic are mainly found in the northern zone, while the Subtropical and Saharian species are mainly found in the Gabes Gulf area. These results confirm the tropical character of this region. The species distribution along the Tunisian coasts is unbalanced; some species appear to be restricted to a particular sector; 54 were recorded only in the northern sector, mainly distributed in cold and temperate waters and 49 only in the southern sector, having mainly affinity for tropical and subtropical waters. *Carcharinus melanopterus*, *Taeniura grabata*, *Pagrus coeruleostictus*, *Rhonchus Caranx*, *Dicentrarchus punctatus*, *Solea aegyptiaca* and species of genus *Epinephelus* and *Serranus*, having frankly tropical or subtropical affinity, are more abundant in the Gulf of Gabes than in the Northern. This work confirms the subtropical fish fauna of Tunisia and especially the Gulf of Gabes. Currently, this character is accentuated by the arrival, in addition to fish Lessepsian, Atlantic species with affinities for warmer waters such as Seriola fasciata, *Sphoeroides cutaneous* and also because of the development of populations *Balistes carolinensis*, *Caranx crysos*, *C. rhonchus*, *Synodus saurus*, *Sparisoma cretense*... The new records are mostly thermophilic species such as the oilfish *Ruvettus pretiosus* (F. Gempylidae) observed recently in the gulf of Gabes. The specimen was 132 cm (TL) and it weighed 11 kg. Some species restricted to this region have been observed more and more in the north. These changes could be a sign of a climate change and global warming in generally. Climate change is operating in the Mediterranean, it is undeniable! The succession of thermal anomalies and so on stability of water masses occurred in the mid 80s would have greatly facilitated the blooms of jellyfish. In Tunisia the appearance of jellyfish was usually in September when vacationers begin to desert beaches. Over the past five years, the phenomenon became early which attracted public attention. The blooms of several species of jellyfish which mainly pulmo *Rhizostoma* were spectacular in May and June 2008 and 2009. This is especially due to climatic reasons that are causing their proliferation and possibly depletion of the leatherback turtle, large predatory of jellyfish. These phenomena could have negative consequences on fish stocks.

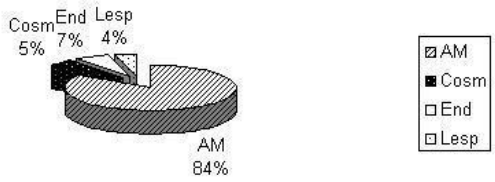


Fig. 1. Biogeographic characteristics of the fish fauna of Tunisia.

References
1 - Quignard J. P., Bouain A., Jarboui O., Ouannes-Ghorbel A., Ben Abdallah L., Zaouali J. & S. Ben Salem., 2004.Bradai M. N.,Ichtyofaune autochtone et exotique des côtes Tunisiennes : Recensement et biogéographie. *Cybium 2004, 28 (4):* 315-328.
2 - Quignard J.-P., 1978. Introduction à l'ichtyologie méditerranéenne : aspect général du peuplement. *Bull. off. natn. Pêch. Tunisie*, 2 : 3 - 21.

PRELIMINARY POPULATION GENETIC STRUCTURE OF THE ENDANGERED DUSKY GROUPER, *EPINEPHELUS MARGINATUS*, IN MALTA AS REVEALED BY SIX MICROSATELLITE MARKERS.

Molly Buchholz-sørensen [1]* and Adriana Vella [1]

[1] Conservation Biology Research Group, University of Malta, Msida, MSD 2080, Malta - molly.sorensen@alumni.ubc.ca

Abstract

The objective of this study is to describe the population structure of the endangered marine fish, *Epinephelus marginatus* (Teleostei: Serranidae), in the Maltese archipelago for the purpose of localized conservation management planning. Preliminary genetic population structure of the Maltese dusky groupers was determined by six microsatellite markers. Initial results based on F_{ST} values comparing three spatial groups (Group A, North Malta; Group B, South Malta; and Group C, Hurd Bank) indicate group A and B are one continuous population inhabiting the Maltese archipelago ($P_{(a\text{-}b)} > 0.05$) whereas group C, an area 23 km east of the main island, is identified as a sub-population to these groups ($P_{(a\text{-}c)} = 0$; $P_{(b\text{-}c)} = 0$). Results suggest that management should be designed to reflect the archipelago as a single population.

Keywords: Biogeography, Conservation, Genetics, Islands, Teleostei

Introduction

The dusky grouper, *Epinephelus marginatus* (Teleostei: Serranidae), is an endangered marine fish considered to be facing a very high risk of extinction in the wild. Due to concerns of population decline throughout their geographic range, the IUCN has currently listed them as endangered (EN) A2d [1]. Their native range includes the Mediterranean Sea, the eastern Atlantic Ocean along the west and south coasts of Africa around the cape to Mozambique as well as Brazil. Characterized by high site fidelity and protracted development to sexual maturity, this reef-associated protogynous hermaphorodite can usually be found in depths up to 50 meters off rocky coastal shores [2]. Localized population structure parameters include pelagic larval dispersal influenced by surface current direction during spawning season along with limited juvenile stage movement. The purpose of this research is to describe and define the status of the Maltese population of dusky groupers in order to best develop a comprehensive conservation management and monitoring strategy.

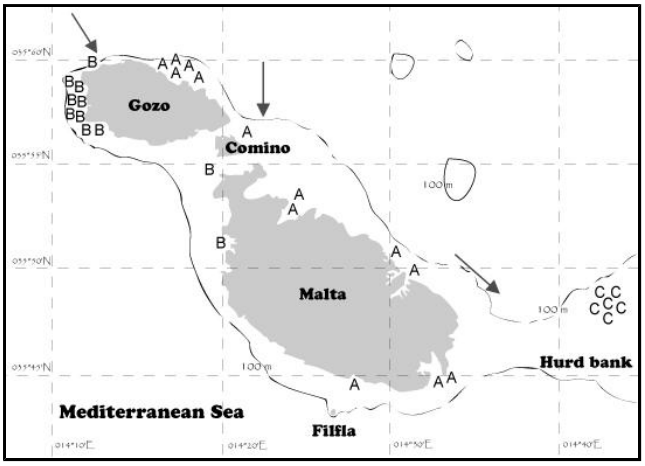


Fig. 1. Map of collection locations for Maltese *E. marginatus* with 100 m bathymetry lines (NTS). Group A, North Malta (n = 13); Group B, South Malta (n = 11); and Group C, Hurd Bank (n = 6). Arrows indicate predominant surface current direction mean [3] for pelagic larval dispersal during the spawning months between June and August

Materials and Methods

A total of 30 dusky grouper specimens with known catch locations were sampled from the Maltese archipelago between 2007-2009. Six fluorescently tagged microsatellite markers were used in this study to explicate the population structure: three primers developed for the red hind grouper [4], *Epinephelus guttatus* (RH_CA_001, RH_CA_002 and RH_CA_008) and three developed for the gag grouper [5], *Mycteroperca microlepis* (GAG010, GAG038 and GAG045). Individuals were genotyped using an Applied Biosystems™ 3130x1 capillary electrophoresis system. Tests of population differentiation were calculated using the software Arlequin [6].

Results

Three sample groups were identified based on log-likelihood assignment tests of individual genotypes to populations (Fig. 1). Within group analysis reveals observed allelic heterozygosity was greatest in group C ($H_{O(a)} = 0.79$, $H_{O(b)} = 0.67$ and $H_{O(c)} = 0.81$) while group A revealed the most unique haplotypes ($n_{(a)} = 31$, $n_{(b)} = 12$ and $n_{(c)} = 3$). Rare breeding size males ($T_L \geqslant 85$ cm) were present in all groups with a significantly higher incidence of large size individuals ($T_L \geqslant 70$ cm) observed in the west Gozo area of group B. Tests of population differentiation reveal little genetic variation between groups A and group B ($F_{ST\,(a\text{-}b)} = 0.01$, $P > 0.05$) while group C shows moderate differentiation from all other groups tested ($F_{ST(a\text{-}c)} = 0.10$, $P = 0$; $F_{ST(b\text{-}c)} = 0.11$, $P = 0$).

Discussion

Results indicate moderate genetic partitioning in a limited spatial range based on biogeographical isolation due to depth range and larval retention patterns. Based on preliminary F_{ST} values, group A and group B are considered to be a single congruent population inhabiting the Maltese archipelago whereas group C is identified as a sub-population to these groups. Due to long life history traits, population decline does not appear to have deleteriously effected within population allelic variation to date. West Gozo has been identified as a possible spawning site and area of conservation interest due to the relatively high concentration of large size individuals. Group A as a whole is also important since it contains a significant number of unique haplotypes. Average south eastern surface currents originating from the northern tip of Gozo during spawning season as a mechanism for pelagic larval dispersal is a probable mode for genetic homogenization within the Malta population. We theorize Gozitan individuals may be an important source population to the rest of the archipelago. Therefore, we recommend management and pilot monitoring efforts initially focus on the northern (group A) and west (group B) Gozitan meta-populations.

References

1 - Cornish A. and Harmelin-Vivien M., 2004. *Epinephelus marginatus*. *In*: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1. <www.iucnredlist.org>. Downloaded on 20 October 2009.

2 - Heemstra P.C. and Randall J.E., 1993. Groupers of the world (Family Serranidae, Subfamily Epinephelinae). An annotated and illustrated catalogue of the grouper, rockcod, hind, coral grouper and lyretail species known to date. *FAO Fish Synop.*, 125(16): 1-382.

3 - International Oceans Institute – Malta Operational Centre, 2006. Malta atmospheric and wave forecasting system. Physical Oceanography Unit, University of Malta. <http://www.capemalta.net/maria.pages.interface>. Downloaded on 3 November 2008.

4 - Ramírez M.A., Patricia-Acevedo J., Planas S., Carlin J.L., Funk S.M. and McMillan W.O., 2006. New microsatellite resources for groupers (Serranidae). *Mol. Ecol. Notes*, 6: 813-817.

5 - Chapman R.W., Sedberry G.R., Koenig C.C. and Elbey B.M., 1999. Stock identification of gag, *Mycteroperca microlepis*, along the southeast coast of the United States. *Mar. Biotechnol.*, 1: 137-146.

6 - Schneider S., Roessli D. and Excoffier L., 2000. Arlequin: A software for population genetics data analysis. Ver 2.000. Genetics and Biometry Lab, Dept. of Anthropology, University of Geneva.

TROPHIC HABITS OF RED SCORPIONFISH *SCORPAENA SCROFA* (OSTEICHTHYES, SCORPAENIFORMES) IN THE CENTRAL WESTERN MEDITERRANEAN

Serenella Cabiddu [1]*, Claudia Pedoni [1], Paola Pesci [1] and Cristina Porcu [1]
[1] Department of Animal Biology and Ecology, University of Cagliari, Italy - cabiddus@unica.it

Abstract
Feeding habits of *Scorpaena scrofa* in the Sardinian waters were analysed. The trophic spectrum of this commercial species was mainly composed of teleosts and crustaceans, in particular Decapoda Natantia, followed by Amphipoda and Decapoda Brachiura. The diet changed according to the sex and the size of the specimens.
Keywords: Diet, Western Mediterranean, Fish Behaviour

Introduction
The red scorpionfish, *Scorpaena scrofa* (L., 1758), is distributed in the Eastern Atlantic and throughout the Mediterranean at depth of 0-370 m [1]. The knowledge about feeding habits of this commercial species is scarce, then the aim of this work is to provide information on the diet by examining specimens captured in the Sardinian waters.

Materials and Methods
A total of 64 specimens, caught at depths from 14 to 119 m, were analysed. The stomachs were removed and preserved in 6% formaldehyde. Each prey item was identified to the lowest possible taxonomic level. The contribution of each food item to the diet was determined by diet indices: %Cv, %F, %N, %W, IRI [2]. The diet breadth was calculated using Levin's standardized index [3], and the intensity of feeding was determined by gastro-somatic index (IG, gut is expressed as percentage of body weight). Difference in diet composition by size (1: 0-11 cm; 2: 11-21 cm; 3: 21-32 cm) and sex were tested by chi-square test.

Results and Discussion
A total of 13 different prey items, belonging to 9 major taxonomic groups, were identified (Table 1). Teleostea was the most important prey category in the diet followed by Crustacea, Mollusca and Tunicata. Among crustaceans the main items were Decapoda Natantia, followed by Amphipoda and Decapoda Brachiura. Stomatopoda, Euphausiacea and Isopoda were occasional prey .
Tab. 1. Trophic spectrum of *Scorpaena scrofa* in the Sardinian waters

Prey item	%F	%N	%W	IRI
TELEOSTEA	62,07	40,43	69,75	6838,74
Teleostea unid.	41,38	34,04	38,97	3021,19
Cepola macrophtalma	3,45	2,13	19,55	74,74
Mullus surmuletus	3,45	2,13	7,33	32,61
Diplodus annularis	3,45	2,13	3,91	20,82
CRUSTACEA	55,17	55,32	13,08	3773,67
Crustacea unid.	10,34	14,89	2,08	175,61
STOMATOPODA	3,45	2,13	4,89	24,19
Meiosquilla desmaresti	3,45	2,13	4,89	24,19
DECAPODA	34,48	25,53	5,99	1086,82
Decapoda unid.	3,45	2,13	0,07	7,59
NATANTIA	24,14	17,02	1,03	435,63
Natantia unid.	17,24	10,64	0,64	194,37
Processa sp.	3,45	2,13	0,24	8,18
Athanas nitescens	3,45	4,26	0,15	15,18
BRACHIURA	6,90	6,38	4,89	77,72
Macropipus arcuatus	3,45	4,26	3,91	28,15
Liocarcinus corrugatus	3,45	2,13	0,98	10,71
EUPHAUSIACEA	3,45	2,13	0,10	7,69
AMPHIPODA	10,34	8,51	0,01	88,14
ISOPODA	3,45	2,13	0,01	7,37
MOLLUSCA	3,45	2,13	17,10	66,31
Sepiola sp.	3,45	2,13	17,10	66,31
TUNICATA	3,45	2,13	0,07	7,56
Taliacea	3,45	2,13	0,07	7,56

Red scorpionfish selected preys according to the size of specimens (Fig. 1 A): Crustacea (IRI1=8041; IRI2=4326) and Teleostea (IRI1=4878; IRI2=10857) dominated the diet in the first and second size classes. The diet of the third size class was more heterogeneous and included Taliacea (IRI1=694) and Cephalopoda (IRI1=210); the importance of Teleostea in the diet increased (IRI1=7495), while the importance of Crustacea decreased (IRI1=1111). Crustaceans taxa changed according to size: Natantia (IRI1=2307) and Amphipoda (IRI1=659) were mainly eaten by youngest specimens whereas Stomatopoda (IRI1=347) and Isopoda (IRI1=209) by adults. Significant difference was found between males and females ($p<0.05$) (Fig. 1 B).

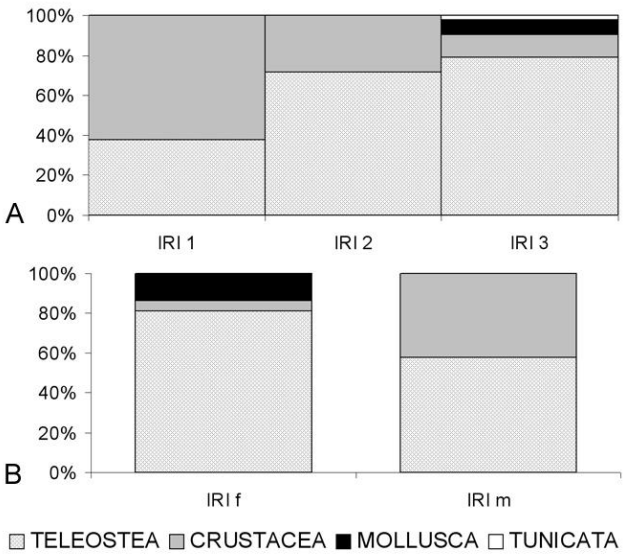


Fig. 1. Changes in diet (IRI) as a function of *Scorpena scrofa* size classes (A) and sex (B)

Teleostea (IRIf=6851; IRIm=6961) was the most important prey in both sexes followed by Crustacea (IRI=5056) in males specimens. The proportion of empty stomachs (Cv=54.69) varied among sexes (males Cv=42.11; females Cv=73.91) and size classes (Cv1=51.85; Cv2=61.07; Cv3=37.50). The IG index value was lightly higher in males than in females (IGm=3,079; IGf=2,964) and increased from the smallest individuals to the largest (IG1=2.652; IG2=3.163; IG3=3.218). Dietary breadth as indicated by Levin's standardized index was 0.316.
The composition of diet suggested that *S. scrofa* was a benthophagous specialized species that preyed mainly on teleosts followed by crustaceans. Results showed that diet was similar to that described for the northern [4] and the southern Mediterranean Sea [5].

References
1 - Fisher W., Bauchot M.L. and Schneider M., 1987. Fishes FAO d'Identification des Espéces pour les Besoins de la Peche. Méditerranée et Mer Noire. Zone de Peche 37. FAO, Rome 1529 p.
2 - Pinkas L., Oliphant M.S. and Iverson I.L.K., 1971. Food habits of albacore, bluefin tuna and bonito in California waters. *Fish. Bull.*, 152: 1-105.
3 - Hurlbert S.H., 1978. The measurement of niche overlap and some relatives. *Ecology*, 59: 66-67.
4 - Harmelin-Vivien M.L., Kaim.Malka R.A., Ledoyer M. and Jacob-Abraham S.S., 1989. Food partitioning among scorpaenid in Mediterranean seagrass beds. *J. Fish Biol*., 3: 715-734.
5 - Bradai M.N. and Bouain A., 1990. Regime alimentaire de *Scorpaena porcus* and *S. scrofa* (Teleostei, Scorpaenidae) di Golfe de Gabes, Tunisie. *Cybium*, 14 (3): 207-216.

SURVEY OF ALGAL CYSTS IN RECENT SEDIMENTS OF THE TRIESTE (ADRIATIC SEA) AND MILAZZO (TYRRHENIAN SEA) PORTS

Marina Cabrini [1]*, Federica Cerino [1], Damiamo Virgilio [2] and Erika Magaletti [3]
[1] Istituto Nazionale di Oceanografia e Geofisica Sperimentale, Trieste, Italy - mcabrini@inogs.it
[2] ARPA FVG, Udine, Italy
[3] Istituto Superiore per la Protezione e la Ricerca Ambientale, Roma, Italy

Abstract
Harbours are generally considered as areas of build-up of algal cysts which can function as potential seeds for pelagic algal populations. In the autumn 2006, a sampling programme of phytoplankton and sediments was carried out in the ports of Trieste (Adriatic Sea) and Milazzo (Tyrrhenian Sea). In both ports, the analyses of water samples revealed a high specific diversity of the phytoplankton community. At the same way, in sediments many cyst morphotypes were identified. Water and sediment analyses confirmed the importance of these areas as potential reservoir of plankton diversity as well as of harmful species.
Keywords: Coastal Systems, Toxic Blooms, Plankton, Adriatic Sea, Tyrrhenian Se

The risk of the introduction of non indigenous plankton species including those of species potentially harmful for the environment and humans has been widely documented in many areas of the world [1]. Considering the potential role of the ballast water as vector for marine introductions [2], ports can represent areas potentially at risk for the high number of ships they receive each year. To analyze the composition of phytoplankton community and algal cyst assemblage in the ports of Milazzo (Tyrrhenian Sea) and Trieste (Adriatic Sea), a sampling programme was carried out from 6 to 7 and from 12 to 14 September 2006, respectively. In seven and eight stations, respectively, phytoplankton nets and sediment cores were collected. The analysis of phytoplankton nets revealed a relatively high specific diversity along the water column in both ports, with more of 120 taxa identified belonging mainly to Bacillariophyceae and Dinophyceae. Various toxic species, such as DSP and PSP species, were identified. Finally, in the Milazzo port, the presence of *Ostreopsis* sp., an epiphytic dinoflagellate responsible for respiratory problems since some years along the Italian coasts, was recorded in many stations. In the port of Trieste, cyst abundance ranged from 459 ind g^{-1} DW recorded at the st. 6 to 3651 ind g^{-1} DW at the st. 3 (Fig. 1).

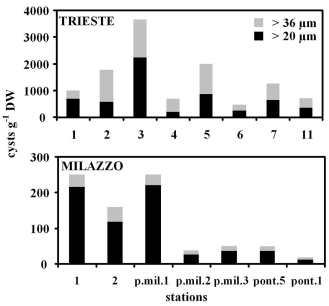


Fig. 1. Cyst abundance (number of cyst g^{-1} of dry weight) at different sampling stations in the ports of Trieste and Milazzo.

A total of 32 different cyst morphotypes belonging to dinoflagellate group were identified at least at genus level. *Alexandrium*, *Protoperidinium* and *Scrippsiella* were the genera more represented. *Calciodinellum operosum* (up to 54 cysts g^{-1} DW), *Lingulodinium polyedrum* (up to 957 cysts g^{-1} DW), *Scrippsiella lachrymosa* (up to 212 cysts g^{-1} DW), *S. trochoidea* (up to 165 cysts g^{-1} DW) and cf. *Woloszynskia* sp. (up to 696 cysts g^{-1} DW) were the most abundant species (Fig. 2). In the port of Milazzo, cyst abundance was lower than those in the port of Trieste, ranging from 19 cysts g^{-1} DW at the st. pont.1 to 250 cysts g^{-1} DW at st. 1 and p.mil. 1. Differently from Trieste, in the port of Milazzo the number of identified morphotypes was lower, although the most abundant types were the same (*Alexandrium* spp., *Lingulodinium polyedrum*, *Scrippsiella* spp.).

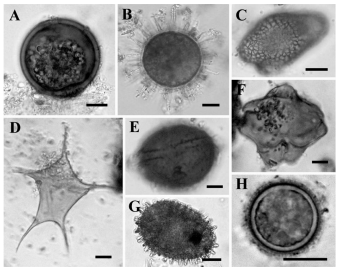


Fig. 2. Some examples of cyst morphotypes identified in this study. **A**: *Diplopsalis* group; **B**: *Lingulodinium polyedrum*; **C**: *Scrippsiella lachrymosa*; **D**: P*rotoperidinium compressum*; **E**: cf. *Zigabikodinium lenticularis*; **F**: *Protoperidinium subinerme*; **G**: *Scrippsiella trochoidea*; **H**: cf. *Woloszynskia* sp. Scale bar = 10 µm.

The analyses of phytoplankton communities and cyst assemblages of the two sampled ports revealed a rather high species diversity. The occurrence of *Warnowia* and *Woloszynskia* cysts (previously observed as cysts in another site in the Gulf of Trieste [3], but never in the water column) suggests that these species may be common members of the phytoplankton community in this area. However, these taxa are very difficult to identify live in plankton samples, and almost impossible in fixed samples. So, this survey of resting forms allow us to deepen our knowledge on phytoplankton biodiversity. Moreover, the identification of species potentially harmful in both water column and sediments highlights the importance of these studies and the necessity to couple the two different kind of sampling, especially in areas at risk such as ports.

References
1 - Hallegraeff G.M., 1993. A review of harmful algal blooms and their apparent global increase. *Phycologia*, 32 (2): 79-99.
2. David M., Gollasch S., Cabrini M., Perkovic M., Bosnjak D., Virgilio D., 2007. Results from the first ballast water sampling study in the Mediterranean Sea - the port of Koper study. *Mar. Poll. Bull.*, 54: 53-65.
3. Cerino F., Virgilio D., Cabrini M., 2008. Dinoflagellate cysts in recent sediments at a coastal station in the Gulf of Trieste (Northern Adriatic Sea). *Biol. Mar. Medit.*, 15 (1): 378-379.

DEPTH AND MESH SIZE EFFECT ON DISCARDING PRACTICES IN TRAMMEL NET FISHERY

Giulia Cambiè [1]*, Anna Cheilari [2], Stefanos Kavadas [3] and George Petrakis [3]
[1] Department of Animal Biology, Vegetal Biology and Ecology, University of A Coruña, Campus da Zapateira s/n, E-15071 A Coruña, Spain. - gcambie@udc.es
[2] European Commission, Joint Research Centre JRC.G.4. Maritime Affairs Unit, Via E. Fermi 2749 (TP 051), 21027 Ispra, Italy
[3] Hellenic Centre for Marine Research, Institute of Marine Biological Resources, Aghios Kosmas, Hellinikon 16610 Athens, Greece

Abstract
Trammel nets are one of the most commonly exploited gears of small scale fisheries used all along the Greek coasts and in Mediterranean. However, knowledge on the discards of this gear is scarce. Discards in trammel net fishery include species with no commercial value, or commercial species, which cannot be distributed in the market because of their small size, or because they come on board already destroyed. The mesh size of the nets and depth of fishing operations are two factors affecting the proportion of the discards.
Keywords: Fisheries, Ionian Sea

Introduction
In general, the coastal fisheries gears are highly species and size selective. The unwanted catches are limited and consequently, the proportion of the fish discarded is low in each fishing operation. Discards in trammel net fishery include species with no commercial value, or commercial species, which cannot be distributed in the market because of their small size, or because they come on board destroyed by polychaetes or other marine organisms while the nets remain into the sea [1]. However, the extended use of the trammel nets by numerous vessels could account for a significant quantity of discards. The aim of this work was to study the discarding practice of trammel nets and the effects of the mesh size, depth and soaking time on the amount of the discards produced.

Material and Methods
Experimental fishing trials with trammel nets of different inner/outer mesh size combinations took place in the Ionian Sea (Greece), during June and July 2004. The mesh sizes used for the inner net were: 44, 56, 72 and 80 mm. The outer panels of the trammel nets had a stretched mesh size of 220, 280, 360 and 400 mm, respectively. All nets were made up of sheets of the four mesh sizes joined end to end to make up a fleet and arranged in random order. Total net length for each mesh size was 500 m. A total of 76 sets of nets were deployed at depths ranging from 10 to 130 m. Normal fishing practices were followed. The nets were set during sunrise and retrieved the following morning, with a soaking time of around 20 h. After hauling, the catch was removed and analyzed separately for each net.
The analysis of the discards was carried out using the logistic regression model. A binomial GLM was used to assess the effect of the soaking time, depth and mesh size on the discard probability, first for all the specimens of all the species caught (n=2144) and then for three of the most abundant species. The goodness of fit was tested using le Cessie-van Houwelingen-Copas-Hosmer test [2] [3] and the ROC (Receiver Operating Characteristic) curve was used to describe the accuracy of diagnostic test.

Results and Discussion
Out of the three covariates used in the logistic regression model for all the specimens of all the species caught, only the depth appeared significant (Tab.1). The le Cessie-van Houwelingen-Copas-Hosmer test (p=0.77, under the null hypothesis assumption that the estimated values by the model are similar to those observed) confirmed that the model fitted the data well.

Tab. 1. Estimates, standard error, and p-value of covariate for the logistic model (*significant at 0.05 critical p-value)

		Logistic model-binomial distribution		
response variable	covariate	estimate	SE	p-value
specimens discarded	Mesh size (mm)	-0.008	0.004	0.06
	Depth (m)	-0.02	0.003	0.05*
	Soaking time (h)	-0.02	0.02	0.44

The regression model showed that the probability of the discard of specimens decreased by about 10% from 10 to 120 m depth (Fig.1A). Although the depth was significant for the logistic model, the area under the ROC curve was 0.52, so the discrimination capacity of the model was very low (Fig. 1B). The same logistic regression model was used to assess the probability of discarding for *Sciaena umbra*, *Merluccius merluccius* and *Pagellus erythrinus*. For *S. umbra* the model showed that only the mesh size was significant: the discard probability using the 44 mm mesh size was greater than for the 72 and 80 mm. For *M. merluccius* and for *P. erythrinus* no covariates were significant.

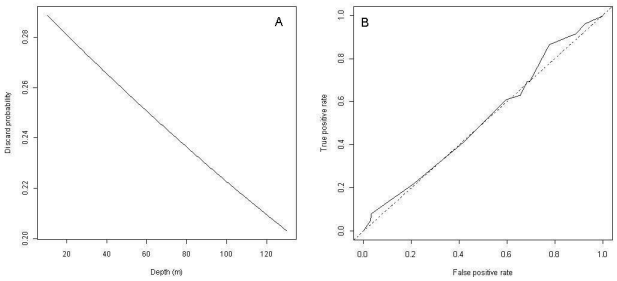


Fig. 1. A) The discards probability estimated as a function of depth by the logistic regression model. B) Receiving operating characteristic (ROC) curve of the predicted discards probability for the specimens caught

The logistic regression analysis showed that, for all the specimens of all the species caught, depth was a significant factor in determining the discard probability: increasing depth decreased the probability of specimens discarded. However depth did not completely explain the discard levels, which were probably related to other factors, such as the presence of scavengers feeding on them (i.e. Polychaetes), the weather conditions and the way of fish capture in the nets. The mesh size was significant in determining the discard levels of *Sciaena umbra*: the smallest mesh size implied more discard probability. In this case the use of larger inner panel mesh sizes could reduce the discard level of the species and could also reduces the handling time spent on board in removing the specimens from the nets.The soaking time did not affect the commerciality of the specimens caught, maybe due to the small difference of this factor between the hauls.
In conclusion this study shows that the depth and the inner panel mesh size affect the discard levels in trammel nets fishery but are not enough to explain them completely; in addition the importance of these factors on discard levels varies by species.

Acknowledgements : This work is part of the research project "Development of an integrated management system to support the sustainability of Greek fisheries resources, IMAS-FISH", financed by the Greek Ministry of Development. The authors are grateful for the help of the master and the crew of the fishing vessels "Kapetan Michalis" and "Aghios Nikolaos".

References
1 - Gonçalves J.M.S., Stergiou K.I., Hernando J.A., Puente E., Moutopoulos D.K., Arregi L., Soriguer M.C., Vilas C., Coelho R and Erzini K., 2007. Discards from experimental trammel nets in southern European small-scale fisheries. *Fish. Res.*, 88: 5–14.
2 - Hosmer DW., Hosmer T., Le Cessie S., Lemeshow S., 1997. A comparison of goodness-of-fit tests for the logistic regression model. *Stat. Med*. 16: 965-980.
3 - Hosmer DW., Lemeshow S., 2000. Applied logistic regression, 2nd edn. John Wiley & Sons, New York.

AN EVALUATION ABOUT THE COLOUR VARIATION OF *CARCINUS AESTUARII* NARDO, 1847 WITH PARTICULAR REFERENCES TO THE FEATURES OF *CARCINUS MAENAS* (LINNAEUS, 1758)

Elif Can [1]*

[1] Dokuz Eylul University, Institute of Marine Sciences and Technology - elif.can@deu.edu.tr

Abstract

The carapace colour variation is distinguished in *Carcinus aestuarii* witha number of 870 male crabs were categorized as green and red. Carapace width of each individual was also measured. The population of *C.aestuarii* followed the terms that the red –coloured crabs were bigger than the green-coloured ones.

Keywords: Estuaries, Crustacea

Introduction

The carapace colour of European green crab, *Carcinus maenas* (Linnaeus, 1758) was referred in several studies, in which a variation is exhibited ranging from light green to deep red [5]. Similar colour variation is also distinguished in the green crab *Carcinus aestuarii*,inhabits the Mediterranean estuarine and lagoons [1]. The differences in terms of behavioral, physiological and ecological features are observed between red and green coloured individuals [2, 3, 4, and 5]. The aim of this study is to identify the features of *C.aestuarii* in order to determine the similarities to *C.maenas* regarding the introduced differences.

Material and Methods

The crabs were collected at monthly intervals for one year from April 2001 to April 2002, by means of a beam trawl. All crabs were counted and sexed. Colour forms were categorized as green and red. Carapace width of each individual was also measured. The male crabs were preferred to be given in this study according to high numbers compared to females. The Mann-Whitney U test is performed to determine the significant differences between green and red forms in terms of carapace width.

Results and Discussion

A number of 870 crabs were categorized as green and red. In this categorization, the red- coloured males had a ratio of 13.6%. The mean carapace width of red males was 29±0.4 mm while the mean carapace width of green forms was 24 ±0.3 mm. Red males were significantly larger than green males ($Z=-6.6$; $p < 0.05$). The population of *C.aestuarii* followed the terms that the red –coloured crabs are bigger than the green-coloured ones, which indicates for both forms of *C.maenas*. Seasonal variation in abundance of red coloured males was observed with small numbers from June to October and during October, the number of individuals increased to the highest (Figure 1). The prediction about the red coloration of the crabs is related to intermolt duration [2, 4] and sexual maturity [5]. According to this approach, red coloured individuals are the mature crabs [5].

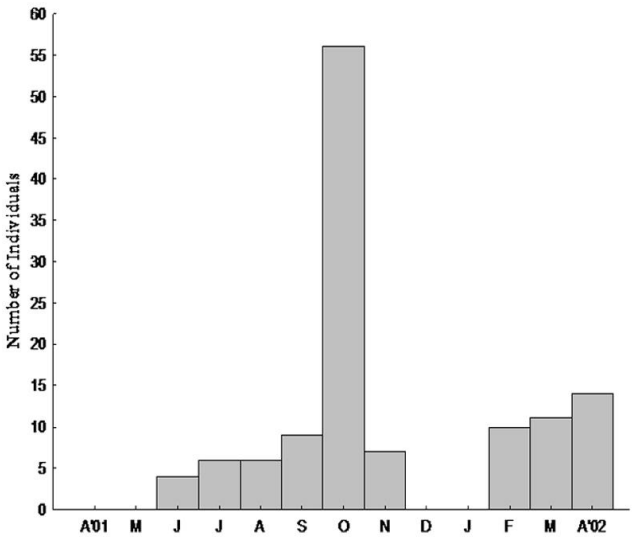


Fig. 1. Monthly variation of red males

References

1 - Furota T., Watanabe, S., Watanabe, T., Akiyama, S., and Kinoshita, K.,1999, Life history of the mediterranean green crab, Carcinus aestuarii Nardo, in Tokyo Bay, Japan, *Crustacean Research*, 28: 5-15.

2 - Mcknight, A., Mathews, L. M., Avery, R. and Lee, K.T., 2000. Distribution is correlated with color phase in green crabs, Carcinus maenas (Linnaeus, 1758) in Southern New England, Crustaceana, 73 (6): 763-768.

3 - Reid, D.G., Abelló, P., Kaiser M. J. and Warman, C. G., 1997. Carapace colour, inter-moult duration and the behavioural and physiological ecology of the shore crab Carcinus maenas, *Estuarine, Coastal and Shelf Science* 44: 203–211.

4 - Styrishave, B., Rewitz, K. and Andersen, O., 2004. Frequency of moulting by shore crabs Carcinus maenas (L.) changes their colour and their success in mating and physiological performance, *Journal of Experimental Marine Biology and Ecology*, 313: 317– 336.

5 - Wolf, F., 1998. Red and green colour forms in the common shore crab Carcinus maenas (L.) (Crustacea: Brachyura: Portunidae): theoretical predictions and empirical data, *Journal of Natural History*, 32: 1807-1812.

GIS MAPPING OF SEABIRD DISTRIBUTION - A PAN-MEDITERRANEAN PERSPECTIVE

Carles Carboneras [1]* and Susana Requena [2]
[1] University of Barcelona, Faculty of Biology, Dept. Animal Biology - carles@gavines.org
[2] Institut de Ciències del Mar, CSIC

Abstract

Seabird distribution in the Mediterranean sea was mapped in GIS format in a 10x10-km grid. The resulting cells were weighed according to the conservation value of the species present. This allowed for numerical calculations and direct comparisons. A network of offshore protected areas is recommended to protect seabird biodiversity in Mediterranean offshore waters, as promoted by UNEP RAC/SPA.

Keywords: Gis, Birds, Marine Parks, Biogeography

The Mediterranean region is home to several species of seabird of high conservation value in global terms (1), with several endemic taxa and some additionally in decline. The protection of the key sites for their survival is an essential tool to ensure their long-term conservation. The UNEP Regional Activity Centre for Specially Protected Areas (RAC/SPA) in compliance with the Mediterranean SPA/BD Protocol undertook an initiative to promote the establishment of a Specially Protected Areas of Mediterranean Importance (SPAMIs) network, including seabirds in Areas Beyond National Jurisdiction (ABNJs). Species' known distribution (both breeding and wintering ranges) were obtained from various sources: published references, consultation to experts, data from censuses at sea and satellite telemetry (2, 3; see 4 for full reference list), plus own data. The information was compiled and mapped in GIS format in a 10x10-km grid following the recommendations of the EEA (5). The resulting cells were assigned a numerical value based on the number of species present and their conservation value (endemic and/or in decline). Treatment of the data allowed for graphic representation and for some geographical calculations, as well as for further analysis along with environmental variables.

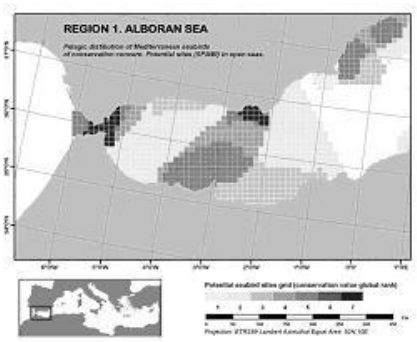


Fig. 1. Sample map of Region 1-Alboran Sea

The following trends were observed:

- the Mediterranean Sea revealed quite heterogeneous in terms of seabird distribution
- nearly two-thirds (59.32%) of the sum of cells had insignificant presence of priority species (cat. 0-1) and large areas of the ocean had relatively low value –with the available information. 'Poor' areas concentrated mostly in the eastern Mediterranean basin, particularly the southern latitudes. Also, in general terms, deep-water areas were poorer in their presence of pelagic birds.
- inversely, priority bird species were present in only about one-third (40.68%) of the total cells
- priority bird species were somewhat dispersed over the areas where they were present; no single cells had a value >7, when the highest possible value was 11
- nearly one-fourth (29.04%) of the sum of cells corresponded to cat. 2-4; these were assigned 'priority B'. The distribution of priority B areas marked the influence of large-scale ocean graphical features (increased productivity, mixing of waters, bathymetric zone) and revealed as a general indicator of areas of conservation interest for seabirds. Given the paucity of data for some species and regions, priority B areas were taken as 'good areas' for the development of a network of marine protected areas for the conservation of seabirds
- less than 10% (11.64%) of the total sum of cells had the highest importance (cat. 5-7) in terms of priority bird species present; these were assigned 'priority A'. Priority A areas are found within the limits of priority B zones in all cases. Characteristically, they are found on the continental shelf, around breeding islands or where key oceanographic features (fronts, upwellings) occur. Also, outstandingly, in the Strait of Gibraltar Information on seabird distribution can be further completed and updated from other sources (telemetry GIS, GLS, PTT) as it becomes available, and used to provide quantitative evidence of use of the [pre]selected areas. Using GIS, seabird distribution can be analyzed against environmental and oceanographic variables, with several examples being provided. This exercise represents an initial step towards the selection of protected areas for seabirds at pan-Mediterranean scale and has been developed in the framework of the activities of UNEP RAC/SPA.

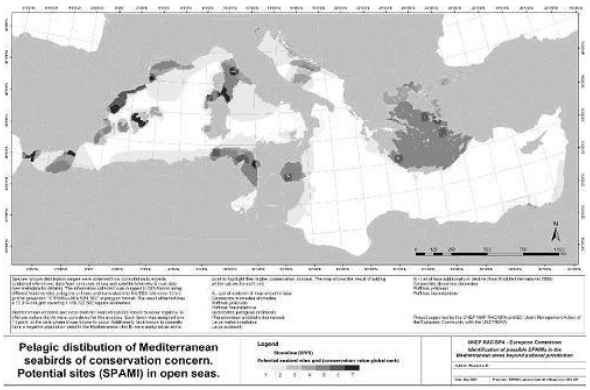


Fig. 2. General map of Mediterranean "Pelagic distribution of Mediterranean seabirds of conservation concern. Potential sites (SPAMI) in open seas"

References

1 - Zotier, R., Bretagnolle, V. & Thibault, J.C. 1999. Biogeography of the marine birds of a confined sea, the Mediterranean. *Journal of Biogeography* 262 297-313.

2 - Carboneras, C. 2008. Marine birds. *In*: Hoyt, E. & Notarbartolo di Sciara, G. Workshop: Species information for managing marine protected areas: improving access and integration. *Proceedings of the IUCN World Congress, Barcelona 5-14 October 2008.*

3 - UNEP - MAP - RAC/SPA, 2006. Proceedings of the First Symposium on the Mediterranean Action Plan for the conservation of marine and coastal birds. Aransay N. edit., Vilanova i la Geltrù (Spain), 17-19 November 2005, RAC/SPA pub. Tunis: 103p.

4 - Requena, S., 2009. Georeferenced compilation on bird important areas in open seas in the Mediterranean region. Contract N 33/2009 Regional Activity Centre for Specially Protected Areas (RAC/SPA), Tunis. 49 pages.

5 - European Environment Agency. 2008. Guide to geographic data and maps. EEA operational guidelines, version 3: December 2008. Available at http://www.eionet.europa.eu/gis.

THE INFLUENCE OF HYDRODYNAMIC PROCESSES ON ZOOPLANKTON TRANSPORT AND DISTRIBUTIONS IN THE NORTH WESTERN MEDITERRANEAN SEA ESTIMATED FROM A LAGRANGIAN MODEL.

François Carlotti [1]*, Zhongfeng Qiu [1] and Andrea Doglioli [1]
[1] Laboratoire d'Ocanographie et de Biogochimie Station Marine d'Endoume, Observatoire des Sciences de -
francois.carlotti@univmed.fr

Abstract
A Lagrangian module has been developed and coupled with the 3D circulation model Symphonie to study the influence of hydrodynamic processes on zooplankton transport and distributions in the North Western Mediterranean (NWM) sea. Forward and backward procedures are used to simulate trajectories of planktonic organisms. The individuals are released from March to October from different places of the NWM to study their transport and tracked for 40 days either as passive particles or with a simple diel vertical migrations (DVM) pattern. Teleconnectivity between different regions of the NWM sea are proposed. The model used backward procedure to study the origin of organisms drifted to the coastal line all around the NWM sea. The patterns of distribution of the jellyfish Pelagia noctiluca are discussed.
Keywords: Models, Zooplankton , Western Mediterranean, Circulation Models, Life Cycles

Zooplankton transport in a variety of physical conditions can be considered as the combination of two closely linked aspects. The first involves zooplankton transport by non-stationary flow field and the second involves the behavioral response of the zooplankton organism, mainly swimming, to changes of environmental conditions. Lagrangian particle-tracking models coupled with hydrodynamic models are particularly efficient tool to examine the role played by various physical processes, to study transport processes over an entire basin and to simulate complex and interactive processes acting at different scales.. The North Western Mediterranean (hereinafter NWM) is a favorable area to study the influence of water circulations and estuarine inputs on biological activity and distributions. In the NWM, large scale circulation is dominated by the Northern Current The NWM sub-basin is one of the most productive areas in Mediterranean owing to important river discharges from the Rhône and Ebre rivers and strong wind mixing on the shelf, and in the open sea the central divergence zones of the Liguro-Provençal and Catalano-Balearic Seas, gyres, upwellings and vertical mixing. In this study, we investigate the influence of the hydrodynamic processes on zooplankton transport and distributions in the NWMS. The model is fully described by Qiu et al. (submitted). We simulate the trajectories of passive particles and vertically migrating organisms in the region by using a lagrangian-particle algorithm driven by velocity fields from a three-dimentional (3D) hydrodynamic model. The model will be used in forward and backward procedures for different objectives. The model domain extends between longitude 1.75°W and 10.90°E and latitude 38.28°N and 5.61°N In order to classify different zones of the NWM as aggregative or dispersive, we divide the model domain into 9 sectors. Sectors 1 and 2 correspond to shelf areas delimited by the isobath of 200m in the GoL and in the Catalan Sea, respectively; sector 3 marks the shelf area around the Balearic islands; sectors 4, 5 and 6 represent the Ligurian Sea (Here sectors 5 and 6 represent di_erent ecosystems in the Ligurian Sea); sector 7 bounds the center of the NWM gyre; sector 8 is the shelf slope where The modeled domain extends between longitude 1.75° W and 10.90° E and latitude 38.28° and 5.61° N (Fig. 1). In order to classify the different zones of the NWM as aggregative or dispersive, we divided the modelled domain into 9 sectors Sectors 1 and 2 correspond to shelf areas delimited by the isobath of 200m in the GoL and in the Catalan Sea, respectively; sector 3 marks the shelf area around the Balearic islands; sectors 4, 5 and 6 represent the Ligurian Sea (sectors 5 and 6 represent different ecosystems in the Ligurian Sea); sector 7 bounds the center of the NWM gyre; sector 8 is the shelf slope where the main branch of the NC passes; sector 9 represents the offshore zone in the Catalan Sea. In a first part, the model is used in forward procedure to study transport from source region to target regions in the way to study connectivity of zooplankton populations between regions in the NWM. Particles are released at D point and R point (Fig. 2) every 3 days from March 1st to August 31, 2001. During the simulations, the particles are simulated as passive zooplankton individuals. The final distributions of the particles are shown in Fig. 3 and 5. The particles released in one month are plotted in one figure. Here Fig. 3 shows the final locations of the particles released at D point and Fig. 5 at R point. The release locations are also included. The percentages of the particles distributions in different sectors are shown in Table 1 and 2. The particles released in one month have been considered as a whole. After 40 days being released at D point, the particles could almost spread anywhere in the NWM (Table 1 and Fig. 1). After being released at D point, the particles are divided into two parts resulting from the currents. One part follows the anticlockwise circulation, first drifts southern and then eastern along the WCC. After reaching the area northeast to the Corsica Island, the particles flow northern along the continental slopes, then return in the NC and go back at D point again. At the end of simulations, this part remains in the sector 4 and 5, i.e. the Ligurian Sea. Another part of the particles follow the NC westward. From the sector 6, the main particles trap in the NC (the sector 8) along the continental slope and then flow into the Catalan Sea (the sector 2 and 9), a part moves more offshore into the sector 7 and a few particles enter in the sector 1 with the intrusion of the NC at the eastern side of the GoL. In the Catalan Sea, the particles reach as far as the Channel of Ibiza where it splits in two parts. The main part re-turn into the Northwestern Basin and some particles enter in the sector 3 (Fig. 1). Strong seasonal patterns in the transport and distributions of the particles are observed (Table 1, Fig. 1). Only 17% of the particles, which released in May and June, maintain in the Ligurian Sea (the sectors 4-6) while the maximum, over 60% in March. On the contrary, only 9% enter in the Catalan Sea (the sectors 2-3 and 9) in March while 46% in May (Table 1). The distributions of the particles in the path areas of the NC are more offshore in July and August than in other months (Fig. 1). At the end of the simulations, the particles scatter in the northeastern part of the Catalan Sea, which released in March and April. The main particles released in July and August concentrate in the path of the NC. And the particles released in May and June distribute mainly similar with the cases in July. However, comparing to only a few particles locate in the northeastward re-turn branch in July, more particles are in the path of the re-turn branch in May and June, even some flow to the areas east to the Balearic Island in May. Moreover, different patterns appear in the final distributions of the particles with different released depths. At the end of the simulations, the main parts of the particles locate in the path of the NC, which release at -100m. The particles released at -5m distribute more complex than those released at -100m, which scatter in the whole areas of the NWM, and the patterns are different in different months. Moreover, along the path of the NC, the particles released at -5m locate further than the particles released at -100m, and only a few of the latter particles reach the open boundary. Others simulations with launched particles from different origins will be presented and zooplankton connectivity between regions will be discussed The model will be used backward procedure to study the origin of organisms drifted to the coastal line all around the NWM sea. This backward procedure is particularly interesting to investigate the patterns of distribution of the jellyfish *Pelagia noctiluca* from the area where coastal jellyfish invasion have been observed, i.e. on the French Riviera, the Gulf of Lions and the Catalan and Balearics seas. The simulations offer a tool to suggest potential pathways of jellyfish transports in the NWM sea.

References
1 - Qiu, Z. F., Doglioli A. M., Z.Y. Hu , P. Marsaleix F., Carlotti, F., 2009. The influence of hydrodynamic processes on zooplankton transport and distributions in the North Western Mediterranean Sea: estimates from a Lagrangian model. *J. Marine Systems* (sous presse).

THE LESSER-SPOTTED DOGFISH (*SCYLIORHINUS CANICULA*): PARASITES AND SCAVENGER HABITS

Margarida Casadevall [1]*, Natàlia Martínez [1] and Pauline King [2]
[1] Girona University, Sciences Faculty - margarida.casadevall@udg.edu
[2] Galway-Mayo Institute of Technology, Galway, Irerland

Abstract

The occurrence of parasites in the digestive tract of the lesser-spotted dogfish (*Scyliorhinus canicula*) caught in the north western Mediterranean was analysed and the results compared with infestation levels in samples of the same species caught in the Atlantic (off the south west coast of Ireland). The relationships between parasite levels and the scavenger habits of the lesser-spotted dogfish are reviewed. The importance of adapting sanitary controls when working with lesser-spotted dogfish on board commercial fishing vessels is emphasised. It is suggested that protocols be adopted so as to prevent increased parasite loading in the lesser-spotted dogfish.

Keywords: Parasitism, Fisheries, Diseases

The lesser-spotted dogfish *Scyliorhinus canicula* (Linnaeus, 1758), a small demersal shark (Carcharhiniformes: Scyliorhinidae), is a broad generalist in its diet and habitat requirements. It is an opportunistic feeder and cannibalism is frequently recorded [1] [2]. While not being a targeted commercial species, it is caught as by-catch, and has a moderate commercial value in the NW Mediterranean traditional fish markets. The lesser-spotted dogfish are primarily a by-catch species of the Irish demersal fishery and are normally discarded in Irish waters [3]. A study of metazoan parasites of the lesser-spotted dogfish [4] from Isle of Man waters, in the Irish Sea, showed some 10 different species of parasites. Three of them were nematodes: *Anisakis simplex*, *Proleptus obtusus* and *Pseudoterranova decipiens*. Henderson and Dunne [5] observed a prevalence of 94% of *Proleptus obtusus* in *Scyliorhinus canicula* from the Galway area on the west coast of Ireland. A previous study in the NW Spain [6] also reported a 91,2% prevalence of *Proleptus obtusus* in *S.canicula*. Also recorded was *Anisakis simplex* (3,5%). To date, no work on nematode parasitism of *S.canicula* in the Mediterranean Sea or off the SW coast of Ireland has been published. In 2008, a total of 130 lesser-spotted dogfish were caught from the NW Mediterranean coast (Blanes, Costa Brava) and 28 individuals from the SW coast of Ireland. Samples were sexed, weighed (gr) and length taken (cm). The stomach contents were weighed and the nematodes were counted, weighed, and preserved in 70% alcohol. Prevalence was calculated as the percentage number of hosts infected with one or more individuals of a particular parasite species, divided by the number of hosts examined; mean abundance as the number of individuals of a particular parasite species in a sample of a particular host species divided by the total number of hosts examined; and mean intensity as the total number of parasites / number of hosts infected by the same parasite. Nearly all (97%) the Mediterranean individuals and all (100%) the Atlantic specimens analysed contained the parasite *Proleptus obtusus* (Physalopteridae, Proleptinae). Individuals of *P. obtusus* found in the stomach were always adults, and some of them were ovigerous females. *S.canicula* would therefore appear be an important host and also a possible infection agent for this parasite. One individual from the Mediterranean area was infested by the larval stage of a parasite clearly belonging to the Fm. Anisakidae, which suggests that *S.canicula* may be an intermediate host for this parasite. In the Mediterranean sample, one stomach also contained an Isopod parasite, *Ceratothoa oestroides*, of the Fm. Anilocridae. Anisakiasis is a zoonotic disease with a dramatic increase in its reported prevalence throughout the world in the last two decades [7]. In the NW Mediterranean coast, fishermen either discard the captured lesser-spotted dogfish (due to the low commercial value) or eviscerate on board, in order to sell the cleaned fillets in the market. McClelland *et al.* [8] and Abollo *et al*. [9] have reported that the lesser-spotted dogfish eat discarded viscera of their own species, leading to increased prevalence of *Anisakis* in fish products. The practice in the Mediterranean of disposing of infected viscera at sea may therefore lead to increased parasite loading on the lesser-spotted dogfish. A change in viscera disposal practices could alleviate this. It is suggested that sanitary controls/protocols be increased for those areas in the Mediterranean implementing such practices. Such protocols should also be extended to include Atlantic waters in the future.

Tab. 1. Nematodes founded on the stomach contents of *S.canicula* individuals, sampled from Mediterranean and Atlantic coasts

Scyliorhinus canicula Nematods	*P.obtusus* Mediterranean	*P.obtusus* Atlantic	F.Anisakidae Mediterranean
% Prevalence	96.9	100	0.8
Mean Abundance	20.7± 27.27	30.25± 32.75	0.008
Mean Intensity	21.64	30.25	1
S.canicula with that sp. of parasite	126	28	1

;

References

1 - Lyle J.M., 1983. Food and feeding habits of the lesser spotted dogfish, *Scyliorhinus canicula* (L.) in Isle of Man waters. *J.Fish. Biol*., 23 (6): 139-148.

2 - Olaso I., Velasco F., Pérez N., 1998. Importance of discarded blue whiting (*Micromessistius poutassou*) in the diet of lesser spotted dogfish (*Scyliorhinus canicula*) in the Cantabrian Sea. *ICES J. Mar. Sci*., 55: 331-341.

3 - Anon., 2008. *The Stock Book.* Annual review of Fish Stocks in 2008 with Management Advice for 2009. Fisheries Science Services, Marine Institute, Ireland.

4 - Moore A.B.M., 2001. Metazoan parasites of the lesser-spotted dogfish *Scyliorhinus canicula* and their potential as stock discrimination tools. *J.Mar. Ass. U.K*., 81: 1009-1013.

5 - Henderson A.C., Dunne J.J., 1998. The Metazoan parasites of the lesser-spotted dogfish *Scyliorhinus canicula* (L.) from the Galway Bay area. *Irish Naturalist's Journal*, 26 (3/4): 104-107.

6 - Sanmartín Durán M.L., Quinteiro P., Ubeira F.M., 1989. Nematode parasites of commercially important fish in NW Spain. *Diseases of Aquatic Organisms*, 7: 75-77.

7 - Chai J.Y., Murrell K.D., Lymbery A.J. 2005. Fish-borne parasitic zoonoses: status and issues. *International Journal of Parasitology*, 35: 1233-1254.

8 - McClelland G., Misra R.K., Martell D.J., 1990. Larval anisakine nematodes in various fish species from Sable Island Bank and vicinity. In: Bowen B.R. (ed) Population biology of sealworm (*Pseudoterranova decipiens*) in relation to its intermediate and seal hosts. *Can. Bull. Fish Aquat. Sci*., 222: 83-118.

9 - Abollo E., Gestal C., Pascual S., 2001. Anisakis infestation in marine fish and cephalopods from Galician waters: an updated perspective. *Parasitol. Res*., 87: 492-499.

VERTICAL DISTRIBUTION OF ANCHOVY EARLY STAGES IN THE ALBORAN SEA: VALIDATING TOOLS FOR IBM ECOLOGY IN A REGIONAL CONTEXT

I. A. Catalán [1]*, I. Álvarez [1], J. Solé [1], D. Macías [2], J. Ruiz [2], J. Tintoré [1] and B. Morales-Nin [1]

[1] IMEDEA: Mediterranean institute for Advanced Studies (CSIC/UIB). C/Miquel Marques 21, CP 07190, Esporles, Balearic Islands, Spain - ignacio@imedea.uib-csic.es

[2] ICMAN: Instituto de Ciencias Marinas de Andalucía (CSIC). Campus Universitario Rio San Pedro, s/n. Puerto Real. Cadiz. E-11519 Spain

Abstract

We offer the first data on vertical distribution of anchovy larvae (*Engraulis encrasicolus*) in the Alboran Sea. Preliminary results show that the vast majority of anchovy larvae distributed in the top 25 m during daytime, suggesting either a lack of vertical migration or a type II migration. Data are discussed in the frame of the potential implications of vertical migration data for spatially-explicit individual-based model escercises being implemented in the area

Keywords: Alboran Sea, Models, Fisheries, Ichthyoplankton

Introduction

Vertical migration of fish larvae is likely to affect their probability of survival. In European anchovy (EA) *Engraulis encrasicolus*, type I vertical migration, implying nocturnal ascent and diurnal descent, has been described in the NW Mediterranean [1]. However, evidence suggests that this is not a species-specific strict behaviour but it may be influenced by the environment: for EA in Benguela, Olivar [2] and Stenevik et al. [3] found either no evidence for vertical migration, with all larvae being at the top 25 m, or a type II (oposite to Type I) vertical migration. This was related to either the presence of a strong thermocline or the avoidance of an offshore Eckman transport layer. Anchovy populations living in the vicinity of the Strait of Gibraltar dwell in coastal areas heavily influenced by the Atlantic Jet, which provokes high mesoscale variability and mixing of Atlantic and Mediterranean waters. Historically, there has been a drastic reduction in the anchovy population hypothetically caused by the combination of man-induced pressure in an area of relatively localized spawning area, together with changes in production processes. Within the SESAME EU project, one case study tackles the analysis of EA changes in abundance through environmental and human forcings in the Alboran Sea. Through the combination of Individual-based models coupled to circulation models, we try to understand the underlying processes regulating mid and long-term fluctuations in the populations. Gathering *in situ* data like vertical migration or growth is one step towards building and validating these models. The objective of this work was to analyse the vertical distribution of anchovy early stages in a coastal area where it spawns, and to interpret the results in the frame of existing dispersion models and vertical distribution data.

Material and Methods

A first excercise to identify the zones in the North Alboran Sea with higher retention probability was perfomed using the outcome of a 3D ROMS (www.myroms.org) ocean climatology of 30 years averaged each 8 days (2 km resolution in the Alboran Sea, MFS used as boundary conditions and ERA-40 for meteorological forcing). The package Ichthyop (www.eco-up.ird.fr/projects/ichthyop) was used to simulate the transport of inert particles from 13 different areas during 12 climatological months. Each monthly run consisted on 65000 particles released between the 50 and 100 m isobath, which drifted for 30 days. They were set to recruit if they spent over 1 day over the 50 m isobath at ages older tan 14 days. To obtain vertical distribution data, an ichthyoplankton-oceanographic survey was conducted in 2008 over the potential spawning zone of EA (Fig. 1). From the 27 stations, preliminary data from the vertical distribution of anchovy eggs and larvae was analysed from 12 stations located at the areas of higher retention, close to Malaga Bay. Vertical distribution was derived from a multinet (HydroBios, 50x50) equiped with 200 microns mesh and set to operate at 25m intervals from 100 m to surface. Plankton samples were preserved in seawater with 4% formalin buffered with Borax. All fish species were sorted and EA eggs and larvae were kept separate for later analysis. The preliminary results shown here correspond to mean abundances per stratum of stations collected during daytime, using stations for which at least the top 2 depth ranges were available.

Results and Discussion

The results of the dispersal model showed that 1) the area close to Malaga Bay showed a significantly higher probability of retention than adjacent zones in the N Alboran Sea, and 2) that this retention was higher from April to September, coinciding with the spawning period of the EA. The surveyed area area was characterised by the presence of mixed Mediterranean-Atlantic waters of 36.6-37at surface, and of Mediterranean waters at deepre layers (Fig.1 A). The signal of the Western Atlantic Gyre, was visible at station 6 from the coast (Fig. 1 A). A strong shallow thermocline at ca. 25 m was present in the area. From the 10987 larvae found, anchovy represented only 1.23 % (135 ind). Eggs were found in low numbers (54) in the vicinity of Malaga Bay, suggesting a very local and patchy spawning, which confirms earlier works [4]. Eggs and larvae agregated in the top 25 m, diminishing sharply afterwards (Fig. 1 B), in relation to the presence of the strong thermocline. The data for Fig. 1 were collected during daytime: although these results are preliminary, there was no evidence to suport the view that larvae performed significant type I migration. We provide the first data on vertical distribution of anchovy in the Alboran Sea. Further analysis of size-based data, and diel rithms will shed more light into the mechanisms driving vertical behaviour in this area, and will be an added value for the spatially-explicit IBM excercises that are being implemented.

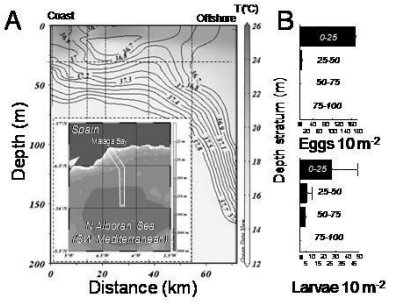


Fig. 1. (A) Salinity (contour) superimposed on a temperature profile (shaded) from a transect of the N Alboran Sea. (B) Median vertical abundances and IQ ranges of anchovy eggs and larvae from positive stations. In A, the stations (dots), transect (rectangle) and the aproximate location of the thermocline (horizontal dashed line) are indicated

References

1 - Palomera I., 1991. Vertical distribution of eggs and larvae of *Engraulis encrasicolus* in stratified waters of the western Mediterranean. *Mar. Biol.*, 111: 37-44.

2 - Olivar M.P., 1990. Spatial patterns of ichthyoplankton distribution in relation to hydrodynamic features in the Northern Benguela region. *Mar. Biol.*, 106: 39-48.

3 - Stevenik E., Sundby S., and Cloete R., 2007. Diel vertical migration of anchovy *Engraulis encrasicolus* larvae in the northern Benguela. *Afr. J. Mar. Sci.*, 29: 127-136.

4 - García A., Cortes D., Ramirez T., Giraldez A. and Carpena A., 2003. Contribution of larval growth rate variability to the recruitment of the Bay of Malaga anchovy (SW Mediterranean) during the 2000-2001 spawning seasons. *Sci Mar* 67: 477-490.

PHENOTYPIC VARIABILITY OF THE KILLIFISH *APHANIUS FASCIATUS* (NARDO, 1827)

Francesco Cavraro [1]*, Vyron Georgalas [1], Stefano Malavasi [1] and Patrizia Torricelli [1]
[1] University Ca' Foscari, Venice - cavraro@unive.it

Abstract

Samples of the cyprinodontid *A. fasciatus* from the Northern and Central basins of the Venice lagoon were compared in terms of phenotipic variability. Results suggest that fishes inhabiting the two basins differ in some life history traits and in the fluctuating asymmetry of lateral bars.

Keywords: Teleostei, Adriatic Sea, Brackish Water, Life Cycles, Conservation

Introduction

Estuaries and coastal lagoons represent important natural areas for fish communities. The Venice Lagoon is the largest lagoon in the Mediterranean basin, covering an area of about 540 km^2. It is characterized by a complex patchwork of shallow water habitats. Among them, saltmarshes offer many different ecological niches and resources to nektonic community. The extension of these habitats is subject to a progressive reduction due to human activities. For these reasons, the European Directive 92/43/EEC ('Habitat' Directive) lists these habitats in Annex I as natural habitats of community interest. *Aphanius fasciatus* (Pisces: Cyprinodontidae) has been considered by previous studies [1] as a typical species characterizing the nektonic community of salt marsh creeks. It is also listed in Annex II of the Habitat Directive as a '*species of community interest whose conservation requires the designation of special areas of conservation*'. Other species belonging to the order Cyprinodontiformes have been used in many studies of environmental monitoring of salt marsh systems [2, 3, 4]. In the present study, first results of the variation of some phenotypic traits between fishes inhabiting two main basins (Northern vs Central) is reported, in order to assess the health of natural populations of *A. fasciatus* and in the perspective of its potential use as "biomonitor" of ecological status and variability of saltmarshes in the Venice lagoon.

Material and Methods

Samples of *A. fasciatus* were collected in the Northern and Central basin of the Venice lagoon using a beach seine. For each specimen a set of phenological traits were collected: Standard Length (SL), Total Weigth (TW) and number of vertical bars on each body side. A Condition Factor CF=(TW*100)/SL^3 was calculated for each individual.

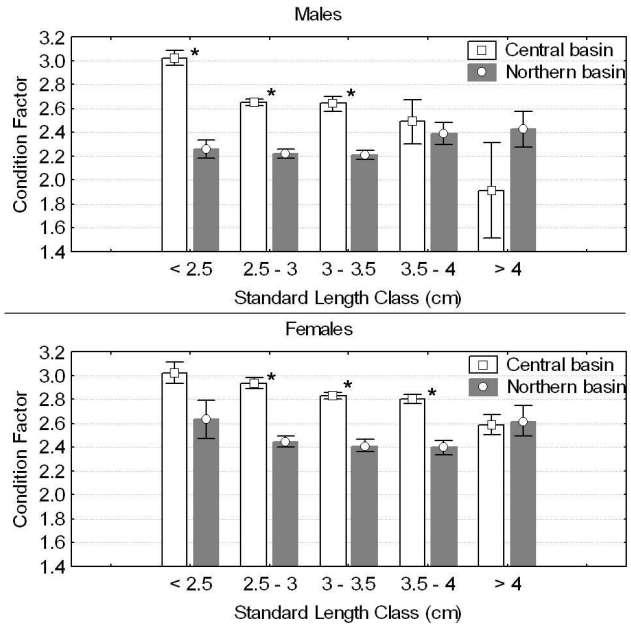


Fig. 1. Condition Factor (mean ± SE) of males and females, calculated for five size classes in the two basins. * = significant statistical difference for p<0.05 by Mann-Whitney test.

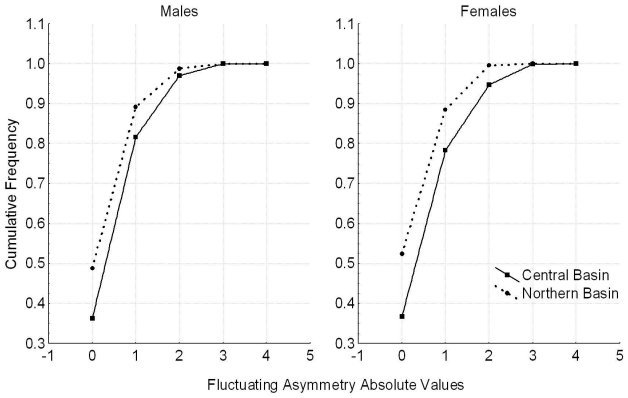


Fig. 2. Cumulative frequencies values of fluctuating asymmetry (FA) in males and females of *A. fasciatus* collected in the Northern and Central basin of the Venice lagoon

The difference in the number of vertical bars between the two body sides was used to assess the absolute values of fluctuating asymmetry (FA) [5] and to test for its variability between the two basins. The degree of FA may be used as indicator of developmental instability due to environmental stress [6]. Males and females were analyzed separately, due to the sexual dimorphism of this species.

Results and Discussion

The mean values of CF of fishes in the Central basin were higher than that of the Northern one within the smaller and intermediate size classes, whereas they were similar or slightly higher in the Northern basin for larger size classes (Figure 1). This suggests the presence of different life history traits, especially in size/age-specific growth rates, or in the level of reproductive and somatic investment. Also the degree of FA changed significantly between the two basins, with higher frequencies of asymmetry in the Central basin (Figure 2). Although further studies are needed to properly explain the patterns of phenotypic variability observed in this species, the differences found between the two basins suggest the potential use of this species as "biomonitor" for the variation of saltmarsh habitat quality.

References

1 - Franco A., Franzoi P., Malavasi S., Riccato F., Torricelli P. and Mainardi D., 2006. Use of shallow water habitats by fish assemblages in a Mediterranean coastal lagoon. *Estuar. Coast. Shelf. Sci.*, 66(1-2): 67-83.

2 - Bush C.P. & and Weis J.S., 1983. Effects of Salinity on Fertilization Success in Two Populations of *Fundulus heteroclitus*. *Biol. Bull.*, 164: 406-417.

3 - Shaughnessy K.S., Belknap A.M., Hewitt L.M., Dubé M.G. and MacLatchy D.L., 2007. Effects of kraft pulp mill condensates on plasma testosterone levels in mummichog (*Fundulus heteroclitus*). *Ecotox. Environ. Saf.*, 67: 140-148.

4 - Meyer J.N. and Di Giulio R.T., 2003. Heritable Adaptation and Fitness Costs in Killifish (*Fundulus heteroclitus*) Inhabiting a Polluted Estuary. *Ecol. Appl.*, 13: 490-503.

5 - Kitevski B. and Pyron M., 2003. Symmetry of banding pattern in banded killifish (Fundulus diaphanus) from Presque isle Bay, Lake Erie. *Jour. Fresh. Ecol.*, 18(2): 229-233.

6 - Lens S., van Dongen S., Wilder C.M., Brooks T.M. and Matthysen E., 1999. Fluctuating asymmetry increases with habitat disturbance in seven bird species of a fragmented afrotropical forest. *Proc. Biol. Sc.*, 266(1425): 1241-1241.

DETERMINATION OF OXIDATIVE STRESS PRECURSORS OF BLEACHED AND NON-BLEACHED ANEMONES FROM TURKISH COASTLINES

Sevilay Cengiz [1] and Levent Cavas [1]*

[1] Dokuz Eylul Uni. Faculty of Arts and Sciences, Department of Chemistry, Izmir-Turkey - lcavas@deu.edu.tr

Abstract

The antioxidant enzyme activities and the lipid peroxidation levels of bleached and non-bleached *Anemonia viridis* from Turkish coastlines were determined in the present study.

Keywords: Aegean Sea, Cnidaria

Introduction

Sea anemones, a group of the order Actinaria, show a symbiosis between cnidarian and an alga commonly known as zooxanthellae. This association is considered to be mutualistic as the two side of the association acquire some benefits from the presence of other side. Despite its benefits to each side, this mutualism must be carefully balanced. If this balance shifts towards to alga, the anemones will be destroyed by the excess O_2 and also the increased reactive oxygen species (ROS) from photosynthesis [1]. Due to their unpaired electrons, the reactive oxygen species react rapidly with some molecules in the body which may cause DNA injury, lipid peroxidation and protein carbonylation [2]. In order to protect themselves against the excess ROS, the anemones expel the alga from their bodies to reconstitute the balance between two sides of symbionts or the photosynthetic pigments of alga are removed. This alga or pigment loss cause whitening which is named "*bleaching"* in the anemone. There are some reports in the literature that elevated temperature, UV exposure, cold shock, pathogenic infections, reduced salinity, unfavorable light conditions or pollution may also be the other factors of bleaching [3]. To the best of our knowledge, this is the first report on the bleaching event of anemone species from the Turkish coastlines. The antioxidant enzyme activities and lipid peroxidation levels of the bleached and non-bleached anemones which were collected from the same locations were investigated in order to see the differences between these individuals.

Materials and Methods

The animals were collected from Dikili-Turkey in May 2009. 0.10 gram of samples was homogenized in 1 mL of phosphate buffer (pH 7.2, 50 mM) with Ultra-Turrax T8 IKA-Werke homogenizator. The homogenates were centrifuged in a refrigerated centrifuge (Hettich 32R) at 10,000 rpm for 10 min at +4°C to remove the cell debris and the supernatants were used in experiments. Total protein concentrations were determined by the Bradford Method using bovine serum albumin (BSA) as standard [4]. SOD activity was assayed by using a commercial kit produced by Randox (SD 125). CAT activity was determined by Aebi's method [5] that measures the decrease in absorbance of H_2O_2 at 240 nm. GSH-Px activity was assayed by using a commercial kit produced by Randox (RS 505). LPO level was measured by measuring the concentration of thiobarbituric acid reactive substances (MDA). The LPO level was calculated by using an extinction coefficient of 155 $mM^{-1}cm^{-1}$ as nmol MDA/g fresh weight of anemones [6]. Student t test was used to evaluate the experimental data. The statistical significance was considered as $p<0.05$.

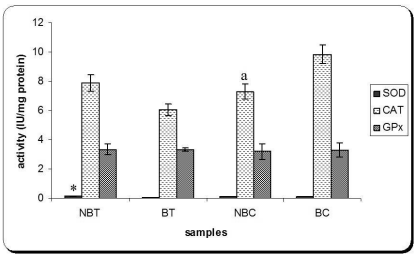


Fig. 1. Antioxidant enzyme activities of bleached and non-bleached anemones. NBT, BT, NBC and BC identify the non-bleached tentacles, bleached tentacles, non-bleached columns and bleached columns, respectively. * shows the statistical differences between the enzyme activities observed in the non-bleached and bleached tentacles. Letter (a) shows the statistical differences between the enzyme activities observed in the non-bleached and bleached columns. The results are the means of three different experiments and the error bars show ±S.E.M

Results and Discussion

In order to evaluate if there is a connection between the bleaching of sea anemones and increased oxidative stress, the antioxidant enzyme activities were determined. The results were presented in Figure 1. SOD activities of non-bleached tentacles were statistically higher than the SOD activities of bleached ones ($p<0.05$). The excess H_2O_2 is scavenged by the activities of CAT. There was a statistically difference between the CAT activities of non-bleached and bleached columns ($p<0.05$). There was no statistical difference between the GPx activities of all species. No statistical differences were observed between the LPO levels of these species. According to the results of present study, there is no correlation between the antioxidant enzyme activities and the bleaching event.

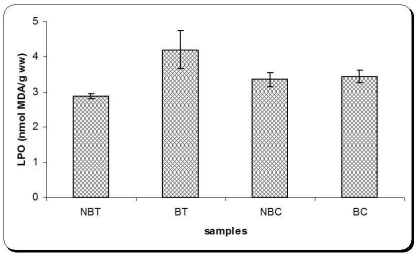


Fig. 2. LPO levels of bleached and non-bleached anemones. NBT, BT, NBC and BC identify the non-bleached tentacles, bleached tentacles, non-bleached columns and bleached columns, respectively. The results are the means of three different experiments and the error bars show ±S.E.M

Acknowledgement

The authors thank to ProjectAWARE for financial support (Grant Number: 639)

References

1 - Sabourault C., Ganot P., Deleury E., Allemand D., Furla P., 2009. Comprehensive EST analysis of the symbiotic sea anemone, *Anemonia viridis*. BMC Genomics, 10, 333-344.

2 - Richier S., Sabourault C., Courtiade J., Zucchini N., Allemand D., 2006. Oxidative stress and apoptotic events during thermal stress in the symbiotic sea anemone, *Anemonia viridis*. FEBS Journal 273, 4186–4198.

3 - Leutenegger A., Kredel S., Gundel S., D'Angelo C., Salih A., Wiedenmann J., 2007. Analysis of fluorescent and non-fluorescent sea anemones from the Mediterranean Sea during a bleaching event.Journal of Experimental Marine Biology and Ecology, 353, 221–234.

4 - Bradford M.M., 1976. A rapid and sensitive method for the quantization of microgram quantities of protein utilizing the principle of protein–dye binding. Analytical Biochemistry, 72, 248–254.

5 - Aebi H., 1985. Catalase. In: Packer, L. (Ed.), Methods in Enzymology. Academic Press, San Diego. pp. 121– 126.

6 - Zhu Z., Wei G., Li J., Qian Q., Yu J., 2004. Silicon alleviates salt stress and increases antioxidant enzymes activity in leaves of salt-stressed cucumber (*Cucumis sativus* L.). Plant Science 167, 527–533.

IDENTIFICATION DU CYCLE DE VIE DE *PROCTOECES MACULATUS* RECOLTE DANS LA LAGUNE DE BIZERTE SITUEE AU NORD-EST DE LA TUNISIE

Tahani Chargui [1], Rim Antar [2], Najoua Trigui El Menif [1] and Lamia Gargouri Ben Abdallah [2]*

[1] Laboratoire de Biosurveillance de l'Environnement, Faculté des Sciences de Bizerte, 7021 Zarzouna, Tunisie

[2] Unité de Biologie, d'écologie et de parasitologie des organismes aquatiques, Faculté des Sciences de Tunis, Manar II, Tunisie - lamiagargouri@yahoo.com

Abstract

Les prospections dans le milieu naturel ont montré que le cycle de *Proctoeces maculatus* s'effectue entièrement dans la lagune de Bizerte. Il comporte comme premier hôte intermédiaire, le mollusque lamellibranche, *Mytilus galloprovincialis* et comme second hôte, *Sabella pavonina* et *Clamys varia*. Ce dernier hôte présente un taux maximal de parasitisme. *S. pavonina* montre une valeur maximale de l'intensité moyenne. L'hôte définitif est représenté par 3 espèces de Sparidés (*Diplodus vulgaris*, *Lithognathus mormyrus*, *Sparus aurata)*. *S. aurata* semble être l'hôte préférentiel de ce parasite

Keywords: Lagoons, Larvae, Life Cycles, Parasitism

Introduction

Les travaux de recherche concernant les digènes parasites des organismes aquatiques provenant des côtes tunisiennes ont concerné, en particulier, la diversité, la morpho-anatomie et la dynamique évolutive des communautés parasitaires infestant les Poissons et les Mollusques [1], [2]. Mis à part les travaux effectués sur le cycle évolutif de *Bucephalus anguillae* parasite de l'anguille et celui de *B. labracis* parasite du loup [3], [4], aucune autre étude se rapportant à cette thématique n'a été entreprise sur les côtes tunisiennes. *Proctoeces maculatus* semble présenter, à l'état larvaire, un danger potentiel élevé pour la mytiliculture (baisse de la vitesse de croissance des moules (1.5 à 2 fois) et mortalité massive de ces mollusques dans le cas d'une hyperinfestation [5], [6]). Dans ce travail, nous nous sommes intéressés, à la détermination du cycle biologique de ce parasite dans la lagune de Bizerte, biotope privilégié de la culture des moules.

Matériel et méthodes

Les moules examinées proviennent de Menzel Jemil (1402 individus) et de Menzel Bourguiba (650 spécimens), stations conchylicoles situées dans la lagune de Bizerte (Nord-est de la Tunisie). La faune associée à ces mollusques est triée, déterminée et maintenue vivante pour la recherche des métacercaires. Cette faune regroupe des Polychètes errants (60 Nereidae, 5 Aphroditidae, 20 Eunicidae, 4 Cirratulidae, 5 Syllidae, 5 Phyllodocidae), des Polychètes sédentaires (59 Sabellidae, 5 Terebellidae, 120 Serpulidae), des Bivalves (39 Pectinidae, 114 Limidae) et des Gastéropodes (170 Muricidae). La dissection de ces animaux est effectuée sous la loupe binoculaire. Les différents organes de chaque animal sont examinés pour détecter la présence éventuelle de parasites. La place, le nombre et l'état de développement de chaque larve sont notés. Les parasites récoltés sont observés au microscope pour être déterminés. Pour la recherche du parasite adulte nous avons examiné 480 sparidés, regroupant 13 espèces (*Boops boops, Diplodus annularis, D. puntazzo, D. sargus, D. vulgaris, Lithognathus mormyrus, Pagellus acarne, P. erythrinus, Pagrus auriga, P. pagrus, Sarpa salpa, Sparus aurata, Spondyliosoma cantharus*) évoluant dans la lagune de Bizerte. Après la dissection de ces poissons, les trématodes sont recherchés dans les différentes parties du tube digestif. Les observations des parasites ont été effectuées *in vivo* et à partir d'individus fixés dans le bouin Hollande, colorés avec le Carmin Boracique, déshydratés puis éclaircis dans l'essence de Girofle et montés entre lame et lamelle dans une goutte de Baume de Canada. La nomenclature appliquée pour la détermination des valeurs épidémiologiques est celle utilisée habituellement [7], [8].

Résultats et discussion

Jusqu'à présent seules les moules provenant de Menzel Jemil ont montré la présence des larves de digènes. Il s'agit de sporocystes et de cercaires de *Proctoeces maculatus*. La fréquence globale de cette infestation ne dépasse pas 0.35%. Les sporocystes infestant la moule colonisent, au début de l'infestation, l'hépatopancréas. A la fin de l'infestation la totalité du manteau se trouve colonisé par les sporocystes ; cet organe présente, alors, l'aspect d'une fine membrane transparente vidée de ses substances de réserves et de ses cellules germinales actives. Une constatation semblable a été faite par d'autres auteurs [6] sur la côte ouest du Cotentin. Les sporocystes récoltés contiennent, selon l'état de maturation, des cellules germinales, des sporocystes fils et des cercaires ou seulement des cercaires. Les cercaires émises de ces sporocystes, peu actives et ne présentant pas de queue, vont, se fixer sur des animaux vivant en association avec les moules. En effet, l'examen de la faune associée a permis de récolter la métacercaire de *P. maculatus* chez une annélide polychète, sédentaire, *Sabella pavonina* et chez un mollusque bivalve, *Clamys varia*, avec respectivement une prévalence de15.25% et 28.20% et une intensité moyenne de 4.88 et 1.36. Ces larves se déplacent librement dans le cœlome des premiers segments des sabelles parasitées. Les métacercaires récoltées chez *C. varia* se trouvent, par contre, enkystées au niveau de la masse viscérale. La métacercaire de *P. maculatus*, récoltée chez des hôtes appartenant à des familles distinctes, présente une large spécificité. Des résultats semblables ont été mentionnés par d'autres auteurs [9], [10] qui ont signalé la présence de ces métacercaires chez des Annélides Polychètes, des Bivalves et des Gastéropodes. L'examen du tube digestif des sparidés nous a permis de détecter le stade adulte de *Proctoeces* chez 3 espèces (*Diplodus vulgaris, Sparus aurata, Lithognathus mormyrus)*, parmi lesquelles, *S. aurata* semble être l'hôte préférentiel (prévalence globale : 15.73%, Intensité moyenne : 2.78). La fréquence de ce parasite est relativement faible chez les deux autres hôtes ; les valeurs de la prévalence et de l'intensité moyenne sont respectivement 6.25% et 1 chez *L. mormyrus* et 4.76% et 1.66 chez *D. vulgarus*. La distribution de *P. maculatus*, au sein du tube digestif, varie selon les espèces ; ce parasite occupant l'intestin antérieur et postérieur chez *S. aurata*, colonise l'œsophage et la partie antérieure de l'intestin chez *L. mormyrus*; chez *D. vulgaris*, ce parasite se limite à l'intestin postérieur.

References

1 - Trigui El-Menif N., Gargouri Ben Abdallah L. & Le Pennec M., 2004. Parasitisme et anomalie de calcification de la coquille observés chez la palourde européenne *Ruditapes decussatus* prélevée dans la région de Sfax. *Rapp. Int. Mer Médit.*, 37 : 448.

2 - Gargouri BEN Abdallah L. & Maamouri F., 2008. Digenean fauna diversity in sparid fish from Tunisian coasts. *Bull. Eur. Ass. Fish Pathol*., 28, (4): 129-137.

3 - Gargouri Ben Abdallah L. & Maamouri F., 2002. Cycle évolutif de *Bucephalus anguillae* Spakulova, Macko, Berrilli & Dezfuli, 2002 (Digenea, Bucephalidae) parasite de *Anguilla anguilla* (L.). *Syst Parasitol*., 53: 207-217.

4 - Gargouri Ben Abdallah L. & Maamouri F., 2005. The life cycle of *Bucephalus labracis* (Paggi and Orecchia, 1965) parasite of *Dicentrarchus labrax*. *Bull. Eur. Ass. Fish Pathol.*, 25 (6): 297-301.

5 - Machkevskii V.K. & Parukhin A.M., 1981. Role of trematodes of the genus *Proctoeces* in some coastal biocenoses of the Black Sea. *Vestn. Zool.* (USSR)., 1: 59-61.

6 - Le Breton J., & Lubet P., 1992. Résultats d'une intervention sur une parasitose à *Proctoeces maculatus* (Trématoda, Digenea) affectant la mytiliculture de l'ouest Cotentin. *Soc. Fr. Malacologie*, 14 : 107-118

7 - Margolis L., Esch G.W., Holms J.C., Kuris A.M. & Schad G.A., 1982. The use of ecological terms in parasitoloy. *J. Parasitol*., 68, 1: 131-133

8 - Buch A. O., Lafferty K. D., Lotz J. M. and Shostak A. W., 1997.Parasitology meets ecology on its own terms : Margolis et al. Revisited. *J. Parasitol*., 83, 4: 575-583.

9 - Prévôt G., 1965. Complément à la connaissance de *Proctoeces maculatus* (Looss, 1901) Odhner, 1911. [syn. *P. erythraeus* Odhner, 1911 et *P. subtenuis* (Linton, 1907) Hanson, 1950]. (Trematoda, Digenea, Fellodistomatidae). *Bull. Soc. Zool. Fr*., 90, 1 : 175-179.

10 - Dollfus R. Ph., 1964. Métacercaria: *Proctoeces progeneticus* (Trématoda Digenea) chez une *Gibbula* (Gasteropoda Prosobranchiata) de la côte atlantique du Maroc. Observations sur la famille Fellodistomatidae. *Ann. Parasit. Hum. Comp*., 39, 6 : 755-744.

COMPOSITION BIOCHIMIQUE D'UN MOLLUSQUE BIVALVE : *MACTRA CORALLINA* DU GOLFE DE TUNIS (KALAAT EL ANDALOUS)

I. Chetoui [1]*, I. Rabeh [1], K. Telahigue [1], N. Ghazali [1], D. Boussoufa [1] and M. El cafsi [1]
[1] Faculté des Sciences de Tunis, 2092, Tunisie - chetouiimene@gmail.com

Abstract
Dans ce travail, nous avons procédé à l'analyse des composés biochimiques des muscles adducteurs et de l'ensemble glande digestive-gonade d'un mollusque bivalve marin *Mactra corallina*. Nous avons relevé une quantité relativement importante d'acide palmitique (C16 :0), d'acide eicosapentaénoîque (EPA, C20 :5n-3) et d'acide docosahexaénoîque (DHA C22 :6 n-3) dans les deux organes étudiés. La teneur en glycogène est plus importante au niveau des muscles adducteurs qu'au niveau de la glande digestive-gonade.
Keywords: Bivalves, Physiology

Introduction
Mactra corallina (Linné, 1758) est un mollusque bivalve qui colonise les sables fins de l'étage infralittoral à faible profondeur allant de 3 à 100 m. Pour la plupart des bivalves, les muscles adducteurs, les glandes digestives et les gonades constituent des organes de stockage de glycogène et de lipides [1]. Dans cette étude, nous avons analysé la composition biochimique des muscles adducteurs et de l'ensemble glande digestive-gonade (acides gras totaux et glycogène).

Matériel et méthode
Les analyses ont été effectuées sur des échantillons de *Mactra corallina* de taille comprise entre 30 et 40 mm dont le poids total est compris entre 19 et 26 g. Ils ont été prélevés durant le mois de mars. Les lipides totaux sont extraits par un mélange de solvants chloroforme méthanol (2/1) selon la méthode de Folch *et al.* [2] et analysés par chromatographie en phase gazeuse (HP 6890). Nous avons utilisé pour nos analyses statistiques un logiciel Statistica 5.0 (ANOVA- MANOVA). Le glycogène total a été analysé par la méthode enzymatique Dubois *et al.* [3].

Résultats et discussion
Cette étude nous a permis d'identifier les acides gras saturés : C14 :0, C16 :0, C18 :0 et C20 :0; les acides gras monoinsaturés C16 :1, C18 :1n-7 et le C20 :1n-7 et les acides gras polyinsaturés C18 :2n-6, C18 :3n-3, C18 :4n-3, C20 :3n-6, C20 :4n-6, C 20 :5n-3 et C22 :6n-3. L'ensemble glande digestive-gonade se caractérise par une teneur élevée en lipides totaux (51,63%) par rapport au muscle adducteur (18,48%). Ces deux organes présentent des pourcentages rapprochés en acide palmitique (C16 :0). L'acide eicosapentaénoîque (EPA, C20 :5n-3) présente un pourcentage élevé au niveau de l'ensemble glande digestive–gonade égal à 27,05%, alors que l'acide docosahexaénoîque (DHA, C22 :6n-3) dépasse les 12% au niveau des muscles adducteurs. Le muscle adducteur est l'organe qui permet l'ouverture et la fermeture des valves, ce qui explique la quantité importante de glycogène (3,44mg/1g) qui constitue chez les bivalves la première source d'énergie utilisée [4] et le seul glucide utilisé pendant la contraction musculaire [5].

References
1 - Caers M., Coutteau P., Cure K., Morales V., Gajardo G., and Sorgeloos P., 1999. The Chilean scallop *Argopecten purpuratus* (Lamarck, 1819): I. fatty acid composition and lipid content of six organs. *Com. Biochem. Physiol. Part B.*, 123: 89–96.
2 - Folch J., Less M., and Sloane-Stanley C.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem*., 266: 497–509.
3 - Dubois M., Gilles K.A., Hamilton J.K., Rebers P.A., and Smith F., 1956. Colorimetric method for determination of sugars and related substances. *Anal. Chem*., 28: 350–356.
4 - Brokordt K.B., and Guderley H.E., 2004. Energetic requirements during Gonad maturation and spawning in scallops: sex differences in *Chlamys islandica. J. Shell fish. Res*., 23: 25-32.
5 - Stewart J.M., Brass M.E., Carlin R.C., and Black H., 1992. Maximal enzyme activities of energy production pathways in the heart, hepatopancreas, and white muscle of the giant scallop (*Placopecren magellanicus*) and lobster (*Homarus americanus*). *Can. J. Zool*., 70: 720-724.

EVALUATION OF MARINE VERTEBRATE BIODIVERSITY OF NORTH CYPRUS COASTAL ZONE ACCORDING TO NATURA 2000 HABITAT TYPES

Burak Ali Çiçek [1]*
[1] EASTERN MEDITERRANEAN UNIVERSITY - burak.cicek@emu.edu.tr

Abstract
In this study, species belong to marine vertebrate biodiversity of Akdeniz, Alagadi, Tatlisu, North Karpaz and South Karpaz Special Environment Protected Areas (SEPA) are listed according to "Natura 2000 Network" habitat types with applying underwater visual census (UVC) method. When compared with previous studies done at the area, it is determined that although covering many of the species, Natura 2000 marine habitat types need to be reevaluated to cover other habitat types and biodiversity in the Mediterranean.
Keywords: Biodiversity, Coastal Waters, Conservation, Eastern Mediterranean, Fishes

Introduction
Over the last 25 years, European Union built up a vast network of over 26,000 protected areas covering all the Member States and a total area of around 850.000 km2, representing more than 20% of total EU territory. It is known as the Natura 2000 network - the largest coherent network of protected areas in the world. The legal basis for the Natura 2000 network comes from the Birds Directive which dates back to 1979 and the Habitats Directive from 1991. Together these Directives constitute the backbone of the EU's internal policy on biodiversity protection [1]. This study is done under EU project "Technical assistance for management and protection of potential Natura 2000 sites in the northern part of Cyprus (Ref No. EuropeAid/125695/C/SER/CY/7)" which is funded by the European Union under the Aid Regulation for the economic development of the Turkish Cypriot community (Council Regulation (EC) No 389/2006) in order to determine marine habitat types and biodiversity in relevant sites located at the coastal zone.

Materials and Methods
This study has been conducted in the marine area of Akdeniz, Alagadi, Tatlisu, North Karpaz and South Karpaz SEPA's of North Cyprus. Cyprus Island is located in the northeastern part of the Mediterranean at 32-34 meridian and 34-35 north latitudes. The island is the only *land* in the Levantine Basin, which is also the third biggest island in the Mediterranean after Sicily and Sardinia. In order to identify the quantity and the quality of the species, underwater visual census (UVC) method has been utilized for this study. UVC, in simple terms, means that the diver collects quality and quantity based data using equipment, which would assist the researcher to breathe. Using the same method, there have been researches conducted at different locations and different habitats [2, 3, 4, 5]. Transects with different habitat (biotope) structures have been identified at every station. The length of these transects were limited with habitat boundaries. The dives on the transects were conducted to and back directions. On the "going" direction, fast swimming vertebrates were recorded through visual documentation. On the same direction, pelagic, benthic and forms in between the two have been counted. On the "back" direction, especially cryptic and small individuals were recorded. On this direction, sampling work has been conducted as well. During the dive, the researcher carried water-proof PVC notebook and a guide book for identification of the species – especially the ones, which can swim fast. After the dive, the notes taken at the PVC notebook would be transferred to the "area registration form". As much as the technical and environmental conditions permit, the species were recorded visually. Canon S-80 digital camera was used for recording the underwater visuals. In April – May 2009, UVC diving were conducted for 23 transects. During the field works species were recorded according to Natura 2000 habitat types as: "1110 Sandbanks which are slightly covered by sea water all the time", "1120 Posidonia beds", "1140 Mudflats and sandflats not covered by seawater at low tide", "1150 Coastal lagoons", "1160 Large shallow inlets and bays", "1170 Reefs" and "8330 Submerged or partially submerged sea caves" In order to better evaluate the habitat diversity cluster analysis was conducted. The cluster analysis for this research was conducted using the PAST package program. Bray-Curtis similarity analysis was used to identify the similarity levels and the results were drawn using the "Bray-Curtis Dendogram" [6].

Results
A total of 50 vertebrate species were recorded during the field works. Types 1120 (n:30), 1160 (n:28) and 1170 (n:39) are found to be biodiversity-rich habitats which cover rocky and/or macrophyte dominated substratum related species. Habitat type 8330 (n:6) includes similar but less number of species in comparison with rocky and/or macrophyte dominated substratum habitat types because of the extreme conditions. Habitat types 1110 (n:8), 1140 (n:2) and 1150 (n:10) covers mainly soft substratum related benthic species except transitory visitors. According to species abundance, cluster analysis showed that habitat type 1140 is dissimilar with all other types. It is observed that, habitat type 1110 which covers bare substratum with sandy bottom is dissimilar with the group of habitats covering high relief rocky and/or macrophyte covered substratum types like 1120, 1170 and 1160 where 1150 and 8330 placed between these two main substratum types. Bray-Curtis Dendogram given in Figure 1.

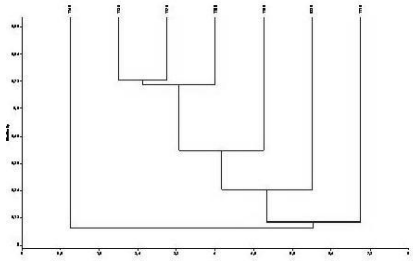


Fig. 1. Bray-Curtis Dendogram.

Conclusion
In this study, vertebrate biodiversity of 7 different Natura 2000 marine habitat types under protection are determined, however in a previous study which was done at similar locations, 83 vertebrate species at 37 different habitat types had been reported [7]. In addition, it is observed that, some habitat definitions appear to be too general, which create difficulties to distinguish and to determine boundaries and organize them in a classification system. It is suggested that, marine habitat classification system of Natura 2000 Network needs to be re-evaluated and the context should be extended in order to cover more habitat types and biodiversity in the Mediterranean.

References
1 - Http://ec.europa.eu/environment/nature/index_en.htm
2 - Bellwood, D. R., 1988, On the use of visual survey methods for estimating reef fish standing stocks, Fishbyte 6, 14-16.
3 - Bibby, C., Jones, M., Marsden, S., 1998, Expedition Field Techniques, Published by the Expedition Advisory Centre, London, 134.
4 - Cappo, M., Brown, I.W., 1996, Evaluation of sampling methods for reef populations of commercial and recreational interest, CRC Reef Research Center Techn. Rep., Townsville, Australia, 6, 72 p.
5 - De Girolamo, M., Mazzoldi, C., 2001, The application of visual census on Mediterranean rocky habitats, *Marine Environmental Research*, 51, 1-16.
6 - Hammer, Q., Harper, D.A.T., Ryan, P.D., 2004, PAST - Palaeontological statistics, ver. 1.25, http://folk.uio.no/ohammer/past/, 64p.
7 - Çiçek, B.A., Yerli, S.V., 2007, Ecology of North Cyprus Coastal Zone, International Symposium on Underwater Research, 22 - 24 March 2007, Famagusta, TRNC.

ASSESSMENT OF SEA TURTLES MONITORING AND RESEARCH STUDIES AT KARPAZ PENINSULA, NORTH CYPRUS

Burak Ali Çiçek [1]*
[1] EASTERN MEDITERRANEAN UNIVERSITY - burak.cicek@emu.edu.tr

Abstract

Sea turtle conservation and monitoring studies in North Cyprus started in 1992 in Alagadi Special Environment Protected Area (SEPA) and the scope had been increased to other sites especially the coasts of Karpaz Peninsula which also cover Karpaz SEPA and South Karpaz SEPA. At the field works in 2007, in Karpaz Peninsula, totally 123 sea turtle nests, 73 of them belonging to *Chelonia mydas* and 42 to *Caretta caretta* with 8 unidentified were determined at 13 nesting beaches, with average nest success percentages of 66.1% and %53.9 in order. In this study, consequences of efforts given to protection and monitoring of sea turtles in the area evaluated in general. Additional protection measures that must be taken at nesting habitats and conservation activities are discussed.

Keywords: Conservation, Monitoring, Turtles, Eastern Mediterranean, Biodiversity

Introduction

All sea turtle species (Chelonioidea) considered as threatened species, where the Mediterranean population of *Chelonia mydas* have been determined as critically endangered [1, 2]. Environment Protection Department (EPD) is in charge of any activities related to the protection and monitoring of the sea turtles at the Karpaz Peninsula in North Cyprus.

Materials and Methods

Nesting habitats in the Karpaz Peninsula are given in Figure 1. The data collection has been conducted in three phases. During the nesting period, nest parameters has been recorded with locations and conservative measures has been taken. In the second phase, an "indirect counting method", this is based on counting the remaining egg-shells and traces of the hatchlings after they emerge; predated eggs during the incubation and emerging periods; and the remaining under-developed eggs at the control opening of the nests, has been employed. The eggs, which have been carried to new locations (hatchery) against flood have been controlled, and checked and their success rates have been recorded with same method. During the last phase of the study, the hatchlings are monitored in the sea. The hatchlings were monitored for three hours in the marine environment to obtain information through measuring the breathing frequency in seconds, identifying directions in the sea and observing predation situation as well as behavioral patterns.



Fig. 1. Study sites in Karpaz Peninsula

Results

In this study, 42 *C. caretta* and 73 *C. mydas* nests have been identified. Additional to the identified species in nests, there are also 8 other nests (unidentified species), which have been located after hatchlings emerge or predation signs have been observed. After the field works conducted, the average success rate of the nests in the Karpaz Peninsula for *C. caretta* has been calculated as 53.9% and 66.1% for *C. mydas*. The data on the behaviors of the hatchlings in the marine environment have been obtained from 7 *C. caretta* and 24 *C. mydas* individuals. The average breathing frequency for the hatchlings of *C. caretta* has been measured at 13.4 seconds per breath, and diving depth at 0.5m. During the observation, apart from one individual, all the others swam towards the open seas. All the monitored *C. caretta* followed a natural process (incubation, emerging and entering the sea) and have managed to reach the sea; however 7 of the *C. mydas* were found in control openings and brought to the sea by researchers. *C. mydas* hatchlings were observed having an average frequency of 14.8 seconds per breath and diving to 0.4m. It was also observed that the two of the seven juveniles monitored did not behave in the normal pattern, furthermore these two hatchlings, in attempt to move forward were doing somersaults. It is suggested that, based on the under-developed nervous systems for balance and directions, their behaviors were distorted.

Conclusions

It was reported [3, 4] that the number of nests fluctuate throughout the years. Based on these data, it is possible to state that the number of nests found in 2007 is within the regular fluctuation ratio. In terms of successful hatchling, the ratio of the total number of eggs laid and the success rate of these eggs are provided in order of year for 1999 to 2006: %58, %65, %66, % 68, %62, %71, %62, and %72 [3]. In this research, *C. mydas* and *C. caretta* species have been evaluated separately. The current situation and the ratio is believed to be as a result of the *C. mydas*, which is more critically endangered and which lays eggs on Ronnas and Ayfilon more often, conservation efforts such as protection-caging and cover against predation, to be more rigorous and more effectively managed. The conservation measures cannot be implemented as effectively as in the northern beaches, which has an effect on the *C. caretta* species because these species frequent those beaches. There is a direct ratio between the less controlled beaches and a higher percentage of predation or hidden nest cases. In this research, the control openings (in order to take the stuck hatchlings, dead ones and removing the eggs) were conducted a day or two after the first emerging time. The live juveniles, in control openings, were put in the sea. Another method for control openings would be that after the natural emerging time, the nest would be controlled for juveniles stuck on the tip of the nest but left without any interference. The control opening should be conducted one week after the last observed hatchling. Even the juveniles are free from the egg shells, their developmental process continues [6]. As this research observed, the two hatchlings, which were found after a control opening, did not swim properly and the others surfaced more frequently for breathing. Even though there could be other reasons for these observations, but it is being thought that the reason for the juveniles' behavior is based on the control openings and the fact that the juveniles were left in the sea before they could complete their physical development. Hatchery operations have been carried out in the Karpaz coasts – especially in Ronnas for a long time to avoid the nests getting flooded [3, 4]. Moreover, this work is carried out by carrying the eggs from different locations of the beach to one spot. However, it is known that, the different temperatures at different points of the beach have an effect on determination of the sea turtle sex ratio [5]. There is a high probability of effecting the male-female ratio if the eggs that have been carried from several nests to one point. Furthermore, it would be safer in view of other risks not to carry all the eggs to one point only. In this respect, the recommended method would be to carry the eggs to higher ground, which is above the water-flood levels and parallel to the original nests.

References

1 - Groombridge, B., 1990, Marine Turtles in the Mediterranean: Distribution, Population Status, Conservation, Council of Europe, Nature and Environment Ser. No. 48, 98pp.

2 - Kasparek M., Godley B.J., Broderick A.C., 2001, Nesting of the Green Turtle, *Chelonia mydas*, in the Mediterranean: a review of status and conservation needs. *Zoology in the Middle East*, 24, 45-74.

3 - Kusetogullari, H., 2007, Conservation of sea turtles in TRNC, II.National Symposium on Sea Turtles, (October, 25-27), Dalyan, Turkey, 36-39.

4 - Senol, A., 2003, Project Report: Conservation of Sea Turtles, Contract No: WSE-PS02-4164, UNOPS, UNDP,USAID, 17 pp.

5 - Hays, G.C., Ashworth, J.S., Barnsley, M.J., Broderick, A.C., Emery, D.R., Godley, B.J., Henwood, A., Jones, E.L., 2001, The importance of sand albedo for the thermal conditions on sea turtle nesting beaches, *Oikos*, 93, 87 - 94.

6 - Dodd, C. K., 1988, Synopsis of the biological data on the loggerhead sea turtle *Caretta caretta* (Linnaeus 1758), U.S. Fish Wildl. Serv., *Biol. Rep. 88* (14), 110 p.

DISTRIBUTION AND MAPPING OF *POSIDONIA OCEANICA* (L.) DELILE IN THE DARDANELLE STRAIT AND MARMARA SEA

S. Cirik [1]*, A. Meinesz [2], B. Akcali [3], F. Javel [2], T. Thibaut [2] and H. B. Ozalp [1]
[1] Canakkale 18 Mart University Fisheries Faculty Terzioglu Kampusu Canakkale - cirik@comu.edu.tr
[2] Dokuz Eylul University Institute of Marine Sciences & Technology
[3] Université de Nice Sophia Antipolis, Laboratorie Environnemant Marin Littoral Park Valrose, NICE

Abstract
In the Mediterranean Sea, the richest coastal marine ecosystems are the *Posidonia oceanica* beds (endemic Mediterranean species). This species is a key ecosystem in the Mediterranean sea and strictly protected (classified list "species strictly protected" in the Bern International Convention). The aim of this study is to better know the distribution of *P. oceanica* in the northeastern boundary (Dardanelle straits and the Sea of Marmara). The lower and upper limits of *Posidonia oceanica* at the Dardanelle Strait was between 0-17 m deep and covered approximately 30 km long at both sides of the Dardanelle Strait. *Posidonia oceanica* is covered the coastline of 3,13 km at Pasalimani Island and 8 km at Kapidag Peninsula.
Keywords: Posidonia, Mapping, Dardanelles, Marmara Sea

Introduction
Posidonia oceanica (L.) Delileis an endemic and the most abundant species in the Mediterranean Sea. It is a protected species (classified list "species strictly protected" in the Bern International Convention). This endemic species forms very dense beds between 0 and 40 m deep. *P. oceanica* growthis very slow (3 $cm.y^{-1}$) and its reproduction by seeds is very rare. *Posidonia oceanica* beds are very sensitive to disturbances caused by human activity (*e.g.* coastal development, pollution, turbidity, anchoring...) and their loss has been observed in a number of regions. Due to its ecological role and to growing concern about its decline, *P. oceanica* is now a protected species in Turkey by the laws. [1; 2; 3; 4,5]. Since the years 1970, repetitive surveys of the seagrass beds became an important way to check on a long term basis the general health of littoral water. They led to stress the relative importance of different causes of the major negative impacts. More recently the effects of the global change on the hydrologic conditions of the Mediterranean Bassin (temperature, salinity, currents, introduced species) can affect the deepest and geographical boundaries of the *P. oceanica* beds and need a particular survey. About the Northeastern Mediterranean Bassin boudaries of the Posidonia beds contradictory informations are available in the general descriptions of the repartition of this seagrass. It is mostly checked absent in the Dardanelle straits and in the Marmara sea [6, 7, 8]. In 2005 an isolated bed of *P. oceanica* has been checked in the middle and southern part of the Sea of Marmara [5]. This region is under extreme hydrologic conditions in comparison for most of the ecological condition of *P. oceanica* development in the Mediterranean Bassin with low salinity and low temperatures dues to the flow of brakish waters coming from the Black Sea [5]. The aim of this study is to better know the distribution and mapping of *P. oceanica* in the northeastern boundary (Dardanelle straits and the Sea of Marmara). Also there are two monitoring stations established at Dardanos (Dardanelle Strait) and Pasalimani Island to monitor the changes about the meadows.

Material and Methods
In 2004 all bibliographical informations on the distribution of *Posidonia oceanica* meadows in the strait of Dardanelles and the Marmara Sea was collected. After that an investigation has done with the professional fishermen and diving clubs around Dardanelle and Marmara Sea with personal communications and questionnaries. The surveys were continued with beamtrawls and dredges. Afterwards field work has done by scuba and skin diving for determinig the upper and lower limits of the *P. oceanica* beds with the help of an GPS. All these data prosesed and put in the digital maps.

Results and Discussion
The distribution of *Posidonia oceanica* beds in Dardanelle and Marmara Sea were; at the Europe side of Dardanelle strait (Seddulbahir, Morto bay,Havuzlar, Kilya bay); at the Anatolian side (Odunluk port, Youth Camp, Dardanos, Kepez, Çanakkale Underwater sports club, at Marmara Sea; Pasalimani Island and Erdek Gulf, Kapidag Peninsula. The lower and upper limits of *Posidonia oceanica* in these stations were between 0-17 m deep. *Posidonia oceanica* covered approximately 31 km long with low density at the Europe side of the Dardanelle Strait and 35 km long at the Anatolian side of the strait. The density of the *P. oceanica* at the Europe side was weaker than the Anatolian side because of the surface currents. *Posidonia oceanica* has seen only at Pasalimani Island and the coastline between Ocaklar and Narli at Kapidag Peninsula at the depth of 2-7 m. In these areas the meadow structure is patchy. The total length of the coastline which is covered with *Posidonia oceanica* is 3,13 km at Pasalimani Island and 8 km at Kapidag Peninsula. All *P. oceanica* rhizomes at the lower limit are plagiotrophic at the monitoring stations. Monitoring of the meadows are still continuing at two station (Dardanos and Pasalimani Island).

References
1 - Pergent G., 1991. La protection légale de la Posidonie en France: un outil efficace - Nécessité de son extension à d'autres pays méditerranéens. In: Boudouresque C.F., Avon M., Gravez V. (eds), *Les espèces marines à protéger en Méditerranée*, GIS Posidonie publ., Marseille: 29-33.
2 - Boudouresque C.F., Gravez V., Meinesz A., Molenaar H., Pergent G., Vitiello P., 1994a. L'herbier à *Posidonia oceanica* en Méditerranée : protection légale et gestion. In: *Actes du colloque scientifique OKEANOS*, Maison de l'Environnement de Montpellier publ., Fr.: 209-220.
3 - Boudouresque C.F., Van Klaveren M.C., Van Klaveren P., 1996. Proposal for a list of threatened or endangered marine and brackish species (plants, invertebrates, fish, turtles and mammals) for inclusion in appendices I, II and III of the Bern Convention. *Council of Europe, Document S/TPVS96/TPVS48E, 96A*: 1-138.
4 - RAC/SPA., 1999. *Action plan for the conservation of marine vegetation in the Mediterranean Sea*. United Nations Environment Programme, Mediterranean Action Plan publ., Tunis, Tunisia: 48 pp.
5 - Meinesz A., Cirik S., Akcali B., Javel F., Migliaccio M., Thibaut T., Yuksek A., Procaccini G., 2009. *Posidonia oceanica* in the Marmara Sea. *Aquatic Botany* 90: 18–22.
6 - Den Hartog, C., 1970. The seagrasses of the world. Nord-Holland. Pub. Company, Amsterdam.
7 - Fischer, W., M. L. Bauchot & M. Schneider (Eds), 1987. *FAO Fiches d' identification des éspèces pour les besoins de la péche. (Revision 1) Mediterranée et Mer Noire Zone de pêche 37. Volume I Vegetaux et Invertebrés*. FAO, Rome, 1–760.
8 - Boudouresque C.F., Meinesz A., 1982. Découverte de l'herbier de Posidonie. *Cah. Parc nation. Port-Cros*, Fr., 4: 1-79.

BIODIVERSITY OF THE MEDITERRANEAN SEA: ESTIMATES, PATTERNS & THREATS

Marta Coll & Co-Authors (*) [1]*

[1] Institut de Ciències del Mar (ICM, CSIC). Barcelona. Spain & Dalhousie University, Biology Department. Halifax, Canada - mcoll@icm.csic.es

Abstract

We reviewed available estimates of marine diversity in the Mediterranean Sea, we depicted main spatial and temporal patterns and we summarized main drivers of change and threats

***Co-authors:** C. Piroddi[3], J. Steenbeek[3], K. Kaschner[4], F. Ben Rais Lasram[5,6], J. Aguzzi[1], E. Ballesteros[7], C. Nike Bianchi[8], J. Corbera[9], T. Dailianis[10,11], R. Danovaro[12], M. Estrada[1], C. Froglia[13], B.S. Galil[14], J.M. Gasol[1], R. Gertwagen[15], J. Gil[7], F. Guilhaumon[5], K. Kesner-Reyes[16], M.-S. Kitsos[10], A. Koukouras[10], N. Lampadariou[17], E. Laxamana[16], C.M. López-Fé de la Cuadra[18], H.K. Lotze[2], D. Martin[7], D. Mouillot[5], D. Oro[19], S. Raicevich[20], J. Rius-Barile[16], J. Ignacio Saiz-Salinas[21], C. San Vicente[22], S. Somot[23], J. Templado[24], X. Turon[7], D. Vafidis [25], R. Villanueva[1] & E. Voultsiadou[10]

Keywords: Biodiversity, Systematics, Mapping, Conservation

(1) Institut de Ciències del Mar (CSIC). Barcelona. Spain; (2) Biology Department, Dalhousie University. Halifax. Canada; (3) Fisheries Center, The University of British Columbia. Vancouver. Canada; (4) Institute of Biology I (Zoology), Albert-Ludwigs-University, Freiburg. Germany; (5) Laboratoire Ecosystèmes Lagunaires UMR 5119, Université Montpellier 2 Montpellier Cedex. France; (6) Laboratoire Ecosystèmes et Ressources Aquatiques, Institut National Agronomique de Tunisie, Tunisia; (7) Centre d'Estudis Avançats de Blanes (CSIC). Girona. Spain; (8) Dipartimento per lo studio del Territorio e delle sue Risorse. Università di Genova, Italy; (9) Carrer Gran, 90, Argentona, Catalonia. Spain; (10) Department of Zoology, Aristoteleio University of Thessaloniki, Thessaloniki. Greece; (11) Hellenic Centre for Marine Research, Institute of Marine Biology and Genetics, Heraclion, Crete, Greece; (12) Dipartimento Scienze del Mare, Polytechnic University of Marche, Ancona. Italy; (13) Istituto di Scienze Marine—CNR, Sede di Ancona, Italy; (14) National Institute of Oceanography, Israel Oceanographic & Limnological Research, Haifa. Israel; (15) Haifa University and Oranim Academic College, Israel; (16) The WorldFish Center-Philippine Office, Los Baños. Philippines; (17) Hellenic Centre for Marine Research, Institute of Oceanography, Heraklion, Crete. Greece; (18) Laboratorio de Biología Marina, Departamento de Fisiología y Zoología. Facultad de Biología, Universidad de Sevilla. Spain; (19) Mediterranean Institute for Advanced Studies (CSIC-UIB). Esporles. Spain; (20) Istituto Superiore per la Ricerca e la Protezione Ambientale (ISPRA). Chioggia. Italy; (21) University of the Basque Country. Bilbao. Spain; (22) C/Nou núm. 8. Creixell, Tarragona. Spain; (23) Météo-France, Centre National de Recherches Météorologiques. Toulouse Cedex. France; (24) Museo Nacional de Ciencias Naturales (CSIC). Madrid. Spain; (25) Department of Ichthyology and Aquatic Environment, University of Thessaly, Magnesia, Greece.

Introduction The aims of our study were (i) to review available estimates of Mediterranean marine biodiversity, and update previous checklists, (ii) to depict the main spatial and temporal patterns of biodiversity, including innovative ways of describing marine diversity, and (iii) to summarize the main drivers of change and threats to marine biodiversity.

Material and Methods We used an extensive bibliographic search combined with the participation of several experts on Mediterranean biota to update publicly available estimates of major taxa, from microscopic organisms to vertebrates. This effort included new estimates of less conspicuous organisms. The new estimate was then compared with previous efforts within the region (1-4), and with online databases, and the state of knowledge by groups was assessed.

We used information available by region or sub-regions and by taxonomic group to depict spatial patterns of marine biodiversity. Patterns of primary producers and most invertebrate species could only be explored at the scale of large regions or basins. Detailed spatial patterns of vertebrate diversity (fish, marine mammals, marine turtles, and seabirds) were analyzed using Geographical Information System software (ArcView by ESRI) covering the Mediterranean basin after available data were digitized (e.g. 5). For each 0.1 degree grid cell, species richness was estimated as the sum of the species co-occurring. We also used the global species distribution model Aquamaps (www.aquamaps.org) to generate standardized range maps of occurrence for marine species. We then compared results with local distribution maps.

To describe temporal changes of diversity over time, we summarized information from several studies (e.g. 6-7) that dealt with the challenge of analysing and integrating diverse data. For the North Adriatic Sea, we included results from Lotze et al. (6) who used a multi-disciplinary approach to assess the ecological changes and overall shift in diversity over historical time scales. We finally identified main current threats to diversity by large taxonomic groups, while special attention was given to climate change scenarios.

Results and Discussion Our analysis identified >17,000 species occurring in the Mediterranean Sea and updated previous estimates that were in the order of 8,000-12,000 species. However, our estimate is still incomplete as more species are likely to be described, especially of smaller and less conspicuous biota. Deep sea areas and portions of the southern region are also still poorly known for several taxonomic groups. In addition, the invasion of new species, especially through the Suez Canal, is a crucial factor that will continue to condition several aspects of Mediterranean marine biodiversity.

Spatial patterns confirmed a general decreasing trend in biodiversity from west to east and north to south, with exceptions. Biodiversity is higher in coastal areas and continental shelves, and decreases with depth. We provide a comprehensive set of species richness maps that represent a baseline for future analysis of biodiversity changes and trends, an important task within the context of global change and associated species' range shifts. The first attempt to depict hotspot areas for vertebrate species in the Mediterranean Sea may be useful for conservation planning (8).

Temporal trends indicate that exploitation and habitat loss where the main drivers of historical changes in biodiversity. More recently, habitat loss and degradation, pollution, climate change, over-exploitation and invasions are the most conspicuous threats that also impact the greatest number of taxa.

An important remaining task is the free distribution of publicly available data from national and regional research initiatives to facilitate updates and enable scientific discussion. We envision the need to continue the collaborative research effort that this work illustrates to further update marine biodiversity registries and narrow down the unknowns.

References

1 - CIESM (1997) Mediterranean Marine Biodiversity, Vol 1. CIESM Workshop Series, Nicosia. 64 pp.

2 - Bianchi CN, Morri C (2000) Marine biodiversity of the Mediterranean Sea: Situation, problems and prospects for future research. Marine Pollution Bulletin 40:367-376.

3 - Boudouresque CF (2004) Marine biodiversity in the Mediterranean: status of species, populations and communities. Scientific Reports of Port-Cros National Park, France 20:97-146.

4 - Hofrichter R (2002) El Mar Mediterráneo. Fauna, Flora, Ecología. II/1. Guía Sistemática y de Identificación., Vol II/1. Ediciones Omega, Barcelona.

5 - Fischer W, Bauchot M, Schneider M (1987a) Fiches FAO d'identification des espèces pour les besoins de la pêche. Méditerranée et Mer Noire, zone de pêche 37, Vol. Service des ressources marines, département des pêches de la FAO.Vol I. Vegetaux et invertebres, Rome, Italie.

6 - Lotze HK, Lenihan HS, Bourque BJ, et al. (2006) Depletion, degradation, and recovery potential of estuaries and coastal seas. Science 312:1806-1809.

7 - Gertwagen R, Raicevich S, Fortibuoni T, Giovanardi O (2008) Il Mare Com'era. Proceedings of the II HMAP Mediterranean and the Black Sea project. Chioggia (Italy), 27th-29th September 2006.

8 - Boero F (2003) State of knowledge of marine and coastal biodiversity in the Mediterranean Sea. Project for the Preparation of a Strategic Action Plan for the Conservation of Biological Diversity in the Mediterranean region (Sap BIO). UNEP Regional Activity Centre, Tunis.

INTERANNUAL VARIATION (2003-2008) OF CALYCOPHORAN SIPHONOPHORES IN THE BAY OF CALVI (CORSICA)

Amandine Collignon [1]*, Anne Goffart [1] and Jean-Henri Hecq [1]
[1] Université de Liège - Océanologie, Centre MARE - Amandine.Collignon@doct.ulg.ac.be

Abstract
The interannual variation of the calycophoran siphonophores was investigated in the Bay of Calvi (Corsica) from 2003 to 2008. The dominant species, *Chelophyes appendiculata* was present throughout the year, with a maximum of reproduction during the summer. Large variations of abundance occur from year to year.
The study of the developmental stages along the year allows us to establish its life cycle, which seems to be correlated with the temperature and mesozooplancton abundance. The cycle takes place each year with a similar seasonal pattern throughout all the study. Other species as *Abylopsis tetragona, Lensia* sp., were also present in lower abundance.
Keywords: Zooplankton , Medusae, Western Mediterranean

Calycophoran siphonophores are widely distributed in the seas all over the world and are planktonic carnivorous predators which could have a major impact on the structure and dynamics of the zooplankton. They may represent up to 20 % of the zooplankton biomass. Copepods are their principal types of prey [1]. *Chelophyes appendiculata* represents the most common species of calycophoran living in the upper layers and is very dominant throughout the northwestern Mediterranean, especially in the area of Ligurian divergence [2] [3]. That species seems to be less abundant or absent in Gibraltar Straight, Alboran sea, in the South Western Mediterranean [1], in the Thyrenean Sea [4] and in the Gulf of Tigulio [5] [6] and finally in the Adriatic where *Muggieae* sp. or *Lensia* sp. are dominant.
A weekly time series of wp2 zooplankton horizontal sampling were carried out at 5 m depth in the Bay of Calvi from 2003 to 2008. The calycophoran siphonophores species have been counted and identified up to the developmental stage according to taxonomic criteria from Bouillon *et al.* [7] and Patriti [8].
In Calvi, the dominant species, *Chelophyes appendiculata* (Eschscholtz, 1829) was present throughout the year, with a maximum of reproduction during the summer. The different developmental stages (nectophores - asexual stage and the eudoxids - sexual stage) appear and follow each other during all the year.
Nectophores are present all the year with a mean density of 12.2 ind/100m³ but are less abundant in winter. Two peaks of abundance were observed one in spring and a larger in autumn. They were dominant in 2006 with a maximal value starting in July (647 ind/100m³).

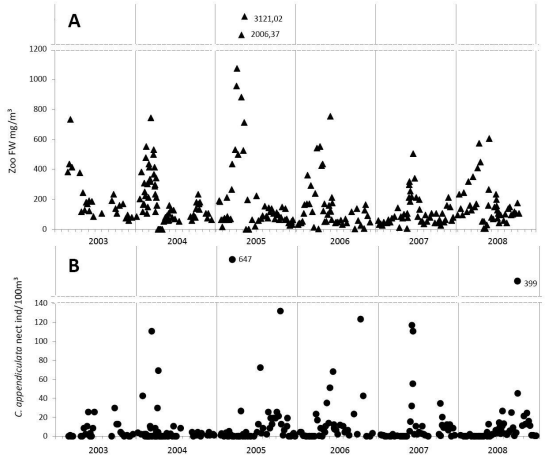


Fig. 1. Interannual variation of zooplancton fresh weight (A) and *C.appendiculata* necotophores (B) in the Bay of Calvi from 2003 to 2008

Eudoxids were less abundant during the winter and maxima occurred from the beginning of spring to the end of summer. The mean density was 0.74 ind/100m³. The highest abundance was noted in the beginning of June (64 ind/100m³).
The early larval stages coming from the sexual reproduction appeared only in a short time during summer.
These results agree with previous investigations made in the northwestern Mediterranean basin concerning the presence and temporal variation of *C. appendiculata* in Villefranche sur Mer [3]. The breading reproduction occurs in summer. The main difference between these studies is that *C. appendiculata*, in Calvi, occurs in larger abundance throughout the year.
This species is a species characteristic of the central waters of the Ligurian divergence [1] and its dominance in Calvi could be explained by the strong influence of offshore waters input Corsican occidental coast [9].
The comparison of the abundance of nectophores of *Chelophyes appendiculata* with the mesozooplankton biomass (fresh weight /m³) shows a good correlation (Fig.1). We have noted that the maximum values of abundances in 2006 and 2008 correspond to years when invasions of *Pelagia noctiluca* were important.
Abylopsis tetragona, was less abundant than *Cheophyes appendiculata* and only the nectophores were counted. This species occurred throughout the year (mean: 1.87 ind/100m³) but was less abundant during winter. The maximum of abundance was observed in May 2004 (27 ind/100m³).
More than other plankton species, siphonophores present variability in composition in different regions of the Mediterranean probably due to local hydroclimatic conditions. Actual data aren't enough to explain these variations. A integrate study of the calycophoran diversity and its variability should be carry out between the different laboratories.

Acknowledgment: The study was done in the program MEDUSE granted by the Agence Française de l'Eau. We thank Sylvain Plazza and the STARESO staff for sampling operations. JH Hecq is Senior research associate to the FRS-FNRS.

References
1 - Purcell J.,1981. Dietary composition and diel feeding patterns of epipelagic siphonophores. *Marine Biology*, 65: 83–90.
2 - Dallot S., Goy J. and Carre C., 1988. Peuplements de carnivores planctoniques gelatineux et structures productives en Mediterranee occidentale. *In*: Minas HJ, NivalP (eds) Oceanographie mediterraneenne. Oceanol Acta (Spec Issue): pp 193-20.
3 - Buecher E., 1999. Appearance of *Chelophyes appendiculata* and *Abylopsis tetragona* (Cnidaria, Siphonophora) in the Bay of Villefranche, northwestern Mediterranean. *Journal of sea research*, 41: 295-307.
4 - Ianora, A. and Scotto di Carlo, B., 1981. The distribution and annual cycles of Siphonophora Calicophora in the Gulf of Naples and adjacent waters. *Arch. Oceanogr. Limnol.*, 20: 51–65.
5 - Licandro P., Ibanez F. and Sertorio Zunini T., 2001. Long term variations of zooplankton in the ligurian sea (western Mediterranean). *Archo Oceanogr. Limnol*., 22: 159-166.
6 - Licandro P., Albertelli G., Batistic M., Carré C., Daly Yahia M.N., Daly Yahia-Kéfi O., Ibanez F., Petrillo M., Sertorio T. and Souissi S., 2004. Increasing dominace of the calycophora siphonophore *Muggiaea* atlantica in different areas of Noth-Western Mediterranean and Adriatic Sea. A possible relationship with hydroclimatic changes. *Rapp. Comm. Int. Mer Médit*., 37: 532.
7 - Bouillon, J., Medel M. D., Pagès F. , Gili J.-M. , Boero F. and Gravili C., 2004. Fauna of the Mediterranean Hydrozoa. *Scientia Marina (Barcelona)*, 68 (Suppl. 2): 5-449.
8 - Patriti G., 1970. Catalogue des cnidaires et cténaires des cotes atlantiques marocaines.(ed.) Série zoologique n°35, Rabat, pp 144.
9 - Goffart A., Hecq J.H. and Prieur L., 1995. Contrôle de la distribution du plancton par le front Liguro-provençal (secteur corse): Evolution saisonnière et variabilité interannuelle. *Oceanologica Acta*,18(3): 329-342.

AN INTER-REGIONAL COMPARISON OF THE DIET OF EUROPEAN ANCHOVY JUVENILES IN THE ADRIATIC SEA AND IN THE GULF OF LIONS

D. Costalago Meruelo [1]*, D. Borme [2], V. Tirelli [2], I. Alvarez [1], A. De Olazabal [2] and I. Palomera Laforga [1]
[1] Institut de Ciències del Mar (CMIMA-CSIC), Passeig Marítim de la Barceloneta, 37-49 - 08003 Barcelon - costalago@icm.csic.es
[2] Dipartimento di Oceanografia Biologica, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Via Piccard 54, 34151 Trieste, Italy.

Abstract
This work was carried out in the framework of SARDONE project to assess and compare the ecology of juveniles of *Engraulis encrasicolus* (L.) in two important fishing areas of the Mediterranean Sea. Although in the Adriatic Sea the mean zooplankton biomass was much higher than in the Gulf of Lions during autumn 2007, the diet of the anchovy juveniles was based mainly on small copepods in both areas. Anchovy prey selectivity seems to point out the preference for few genera: *Temora*, *Oncaea*, *Euterpina* in the Adriatic and *Temora*, *Microsetella* and *Corycaeus* in the Gulf of Lions.
Keywords: Diet, Pelagic, Gulf Of Lions, Adriatic Sea, Zooplankton

Introduction
Small pelagic fish are essential mid trophic levels of the food web and play a major role in the ecosystems in terms of trophic flows and biomasses in the Mediterranean Sea [1, 2]. European anchovy, *Engraulis encrasicolus* (L.), can be found throughout the Mediterranean Sea, being the most important fishery of small pelagic fish in two of the major stocks (North-western Mediterranean and Adriatic Sea). Since the fishing pressure exercised over *E. encrasicolus* is exceptionally high in these areas [1], different studies have been carried out in order to improve the knowledge on the trophic ecology of this species [3, 4]. However, differences in the diet of anchovy juveniles between the Adriatic and the Gulf of Lions have never been studied. Here we present the first work that compares the trophic behaviour of anchovy in these two regions.

Materials and Methods
Two cruises were carried out in the Gulf of Lions (Northwestern Mediterranean) and in the Po river Delta (Northwestern Adriatic Sea) in December and November 2007, respectively. Plankton samples were collected by vertical tows with a standard WP2 net (mesh size of 200 µm) for mesozooplankton, and by means of a modified Calvet net (mesh size of 53 µm), for microplankton. Juveniles of *Engraulis encrasicolus* were captured with a small pelagic trawling net. The total length and the weight of the individuals were measured. The feeding preferences were assessed using the Ivlev´s dietary selectivity index [5].

Results and Discussion
In the Adriatic Sea mean microplankton biomass was 67.04 $mg*m^{-3}$ and mesozooplankton biomass was 29.04 $mg*m^{-3}$ while in the Gulf of Lions mean biomass was 11.38 $mg*m^{-3}$ and 7.04 $mg*m^{-3}$ of microplankton and mesozooplankton respectively. Anchovies total length ranged between 45 and 86 mm in the Adriatic Sea, and between 48 and 110 mm in the Gulf of Lions. The composition of the stomach contents in the Adriatic and in the Gulf of Lions was basically made-up of small copepod (adults and copepodites). Ivlev´s selectivity index (Fig. 1) pointed out a preference for *Temora* spp, *Oncaea* spp. and *Euterpina acutifrons* in the Adriatic,. In the Gulf of Lions, the most highly selected preys were mainly *Microsetella rosea*, *Temora* spp.and *Corycaeus/Farranula*, but decapod larvae and other crustaceans were also positively selected. *Temora spp.* was preferred in the same proportion in both the areas, but , in the Gulf of Lions the feeding selectivity covered a wider range of prey.

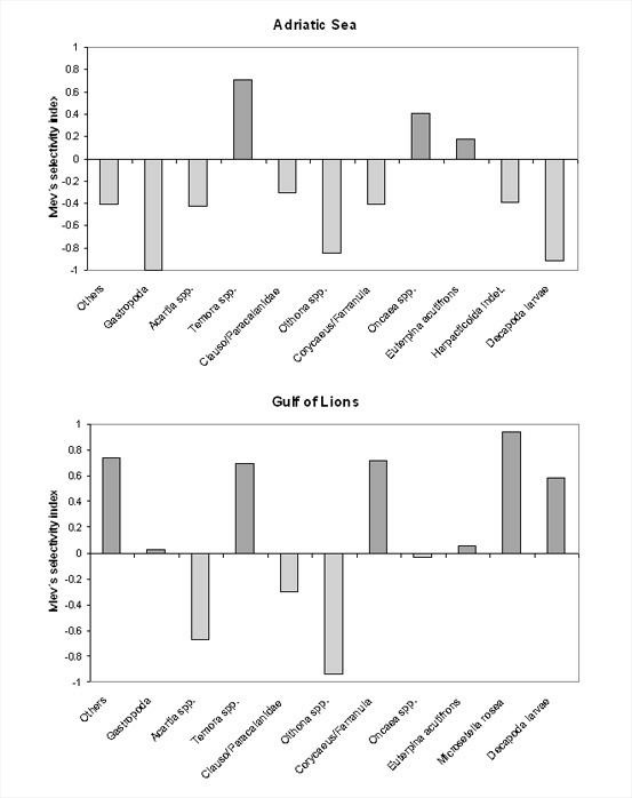


Fig. 1. Ivlev´s diet selectivity index of juvenile anchovies

References
1 - Coll M., Palomera I., Tudela S. and Sardà F., 2006. Trophic flows, ecosystem structure and fishing impacts in the South Catalan Sea, Northwestern Mediterranean. *J. Mar. Syst.*, 59: 63-96.
2 - Coll M., Santojanni, A., Palomera I., Tudela S. and Arneri, E., 2007. An ecological model of the Northern and Central Adriatic Sea:Analysis of ecosystem structure and fishing impacts. *J. Mar. Syst.*, 67: 119-154.
3 - Borme D., Tirelli V., Brandt SB., Fonda Umani S. and Arneri E., 2009. Diet of *Engraulis encrasicolus* in the northern Adriatic Sea (Mediterranean): ontogenetic changes and feeding selectivity. *Mar. Ecol. Prog. Ser.* 392: 193-209.
4 - Tudela S. and Palomera I., 1997. Trophic ecology of the European anchovy *Engraulis encrasicolus* in the Catalan Sea (north-west Mediterranean). *Mar. Ecol. Prog. Ser.* 160: 121-134.
5 - Ivlev VS. 1961., Experimental ecology of the feeding of fishes. Yale University Press, New Haven, Connecticut.

ASSESSMENT OF MORPHOMETRIC PARAMETERS OF TUNA *THUNNUS THYNNUS* (LINNAEUS, 1758) BASED ON MUSEUM EXHIBITS, DUBROVNIK NATURAL HISTORY MUSEUM

Marija Crncevic 1, Marijana Cukrov 2 * and Katarina Ivanišin-Kardum 1
[1] Dubrovnik Natural History Museum, Androviceva 1, 20000 Dubrovnik, Croatia - mcrncevic@dubrovnik.hr
[2] Croatian Biospeleological Society, Demetrova 1, 10000 Zagreb

Abstract
The natural objects of the Dubrovnik Natural History Museum, such as the head and the caudal fin of tuna *Thunnus thynnus* (Linnaeus, 1758.), which as species is listed on the Red list of threatened plants and animals of Croatia, are a valuable source of data of this threatened species in the Adriatic Sea. These Museum objects, as well as the relevant existing written historical documents and existing scientific knowledge regarding tuna were used to assess the morphometric characteristics. The parameters will be used in construction of a credible complete model of tuna that will form part of the Museum permanent collection, with emphases on its educational aspects.
Keywords: Adriatic Sea, Pelagic, Fishes

Introduction
The dermoplastic preparations of the head (Figure 1) and the caudal fin of tuna *Thunnus thynnus* (Linnaeus, 1758) belong to the particularly valuable natural objects of the Dubrovnik Natural History Museum. According to the written data it was caught near the small town Ston in 1897 and it weighed around 275 kg [1].

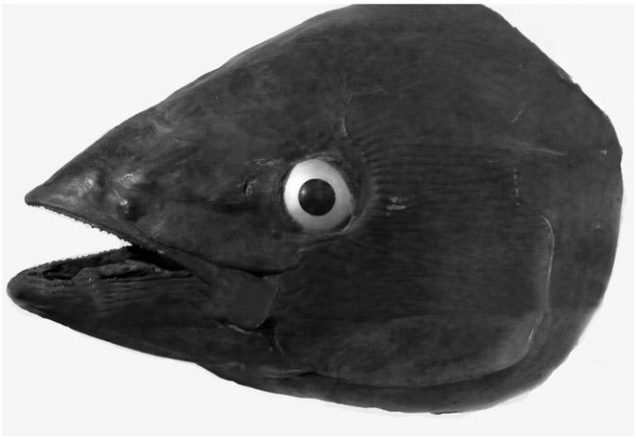


Fig. 1. The dermoplastic preparation of the head of tuna *T. thynnus*, Dubrovnik Natural History Museum

Tuna is a large and high migratory species. Usually they school by size. This fast swimming bony fish occurred in almost whole Adriatic Sea: along the coast, in channels and especially in open sea, rare along the Istria coast [2]. Tuna fishing have a long tradition in Croatia.

Due to its economic value the population of tuna in the Adriatic Sea has been significantly reduced. According to the IUCN categorisation, these species have been included in the Red book of sea fishes of Croatia [2]. In line with the legislation of the Republic of Croatia, tuna is a protected species [3], and fishing is regulated by the catch quotas in accordance with recommendations of the International Commission for the Conservation of Atlantic Tunas [4].

Material and Methods
On the basis of morphometric characteristics of the Museum exhibits: diameter of the eye, length of the head and the preorbital length, as well as on the information supplied on the weight of the caught tuna and the scientific knowledge of tuna, mathematical methods were used to calculate its overall morphometric values and to define its meristic properties (Table 1) [2, 5, 6]. The same data will be used for construction of the model of life size tuna that will, as a Museum exhibit, form part of the Museum permanent collection.

Results and Discussion

Tab. 1. Morphometric and meristic characteristics of tuna *Thunnus thynnus*

Morphometric characteristics	**Length (cm)**
Total length	258.0
Standard length	230.0
Fork length	235.0
Pre-anal length	146.5
Pre-dorsal length	71.2
Pre-pelvic length	78.1
Pre-pectoral length	71.9
Body depth	74.0
Head length	66.5
Eye diameter	10.6
Pre-orbital length	18.6
Wide caudal fin	67.2
Meristic characteristics	**Number**
D_1 first dorsal fin	XIII
D_2 second dorsal fin	I + 13
A anal fin	II + 12
V pelvic fin	I + 5
dorsal finlets	10
ventral finlets	9

Construction of the complete Museum object and accompanying, organised educational programmes, will contribute to indication of the status of these threatened species: the need for preservation and the necessity for enforcement of measures of the protection and the economy.

References
1 - Mušin D., 1989. Ichtiological collection (Cyclostomata, Selachii, Osteichthyes) of the Natural History museum of the Biological Institute, Dubrovnik. *Zbornik Matice srpske za prirodne nauke* 76: 137-168.
2 - Jardas I., Pallaoro A., Vrgoc N., Jukic-Peladic S. and Dadic V., 2008. Red book of sea fishes of Croatia, Zagreb, Ministry of Culture, State Institute for Nature Protection, 396 pp. (in Croatian).
3 - Regulation on Protection of Wild Taxa (Official Gazette No. 99/09)
4 - Regulation on authorized catch, farming and trade Thunnus thynnus (Official Gazette No. 123/07, 69/08, 13/09).
5 - Sinovcic G., Franicevic M., Zorica B. And Cikeš-Kec V., 2004. length-weight and lenght-lenght relationships for 10 pelagic species from the Adriatic Sea (Croatia). *J. Appl. Ichtiol*. 20 (2): 156-158.
6 - Ricker W.E., 1975. Computation and intrepretation of biological statistic of fish population. *Bull. Fish. Res.* Board Can., 191: 382 pp.

FIRST RECORD OF THE INTRODUCED FOULING TUBEWORM *FICOPOMATUS ENIGMATICUS* (FAUVEL, 1923) IN THE EASTERN ADRIATIC SEA, CROATIA

Marijana Cukrov [1], Marija Despalatovic [2], Ante Žuljevic [2] and Neven Cukrov [3]*
[1] Rudjer Boskovic Institute - ncukrov@irb.hr
[2] Croatian Biospeleological Society
[3] Institute of Oceanography and Fisheries

Abstract
Alien species *Ficopomatus enigmaticus* was recorded on two locations along the eastern Adriatic coast, Krka River Estuary and Neretva River Delta. It is probably introduced as ship fouling.
Keywords: Adriatic Sea, Brackish Water, Species Introduction, Polychaeta

Introduction
Ficopomatus enigmaticus (Fauvel, 1923), previously know as *Mercierella enigmatica*, is sedentary suspension-feeding polychaete belonging to family Serpulidae. These polychaete worms build and live in upright white calcareous tubes that have distinctive collar like rings at irregular intervals. It is reproducing successfully on temperatures around 18°C [1, 2]. It is cryptic species probably invaded the Mediterranean Sea as ship fouling during the First World War [3]. The first record in Europe was in the Channel de Caen in the northern France in 1921. In the Adriatic Sea, *F. enigmaticus* was recorded for the first time in the Venice Lagoon, the Northern Adriatic [4]. Today, it builds huge aggregate "reefs" in the Po River Delta [2].

F. enigmaticus was recently recorded at two new locations along the eastern coast of the Adriatic Sea, Krka River Estuary and Neretva River Delta (Fig. 1). The investigations of both records were performed by scuba divers. The first location, Krka River, is situated in the karst region and its estuary, with total length of 22 km, was formed during the Holocene transgression. In the lower part of estuary, the Port of Šibenik is located. It is a typical example of a stratified estuary which bottom gradually deepens from 2 m to 42 m.



Fig. 1. Locations of the F. enigmaticus appearance

Around the shores of the lower part of the Krka River Estuary *F. enigmaticus* occurs as single tubes or as large dense fouling aggregations mostly on artificial substrates like cement (seawalls) and iron construction (Fig. 2). It exists at depths up to 3 m, but the largest settlements are up to 0.5 m. Hull encrustations are up to 25 cm thick reaching the water surface during the low tide. We have found larger fouling aggregations only at three sites. Also, it makes fouling in community with *Mytilus galloprovincialis*. The intertwined tubes are often coated with bryozoans. Additionally, along the coast we have observed dead fragments of fouling aggregations with domination of *F. enigmaticus* tubes. Probably, that fouling aggregates collapses due to excess weight or mortality during the winter due the exposure to low temperatures for long period, low salinity and flow intensity.



Fig. 2. Photo of F. enigmaticus from the Krka River Estuary (July, 2009.)

The second location, Neretva River Delta, covers about 20 000 ha of which 12 000 ha are in Croatia. It is constituted of numerous channels. The Port of Ploce is situated near the river mouth, and it is one of the main Croatian ports. In this area, *F. enigmaticus* occurs in two delta's channels as single specimens or in small aggregates regularly in communities with *Balanus* sp. It mostly occurs at depths of 0.7 m. The fishes from genus *Syngnathus*were observed as main predators on fouling tubeworm in this area.

Conclusion
The fact that populations of *F. enigmaticus* appear near the ports suggests that the probable mechanism of introduction was ship fouling. Also, appropriate environmental factors on these locations enable growth of the species.

References
1 - Dixon D.R. 1981. Reproductive biology of the serpulid *F. (Mercierella) enigmaticus* in the Thames estuary S.E. England. *J. Mar. Biol. Assoc. U.K.*, 61: 805-815.

2 - Bianchi C.N. and Morri C. 1996. Ficopomatus 'reefs' in the Po River Delta (Northern Adriatic): their constructional dynamics, biology, and influences on the brackish-water biota. PSZN I: *Mar. Ecol.*, 17: 51-66.

3 - Zibrowius H. 1992. Ongoing modification of the Mediterranean marine fauna and flora by the establishment of exotic species. *Mésogée*, 51: 83-107.

4 - Fauvel P. 1938. Annelida Polychaeta della Laguna di Venezia. *R. Com. Talas. It. Mem.*, 246: 1-26.

MARINE MOLLUSC FAUNA OF KASTAMONU AND SINOP COASTS (THE SOUTHERN BLACK SEA, TURKEY)

Mehmet Culha [1]*

[1] COMU, Fisheries Fac.,Hydrobiology dept., Terzioglu camp. 17100. C.kale - msculha@gmail.com

Abstract

The study was carried out to determine Mollusca fauna of Kastamonu and Sinop coasts. A seasonal sampling procedure was performed in the area from a variety of biotops in 0-0.5 and 5m depths at 4 stations between July 2007 and May 2008. A total of 11 species and 16823 specimens belonging to Bivalvia; 15 species and 5482 specimens belonging to Gastropoda and 1 species and 1 specimens belonging to Polyplacophora classes were encountered during the study. Also, the seasonal distribution of the physicochemical parameters measured on site as in-situ. In addition to, analytical procedure and minimum and maximum ranges with (Mean±SD) are shown.

Keywords: Mollusca, Black Sea, Biodiversity

Introduction The biodiversity of the Black Sea ecosystem includes some 2,050 species of animals including Arthropoda, Molluscs (206), Echinodermata, Fish and Mammals (1). As far as Turkey is concerned, the investigations on mollusk biodiversity of the Black Sea are quite scanty and limited to information depth of finding and other details, except for Russian, Ukraine and Romania, some another countries coasts of the Black Sea. There have been some studies on Mollusca in Turkish coasts of the Black Sea. These studies have begun since years of 1960'. 11 by Caspers (1968); 49 by Bacescu et al. (1971), 37 by Fisher et al. (1987), 37 by Mutlu et al. (1993), 49 by Kocatas et al. (2000), 108 by Ozturk (1998), 50 by Ozturk and Cevik (2000), 16 by Culha et al. (2000), 99 by Demir (2003), 23 by Demirci and Katagan (2004), 28 by Culha (2004), 8 species by Luth (2004), 26 by Ozturk et al. (2004), 33 by Demirci (2005), 14 by Culha et al. (2007), 15 species by Culha et al. (2007) were reported. As a result of the studies in Turkish coasts of the Black Sea carried out up to now, 183 Mollusca species have been identified.

Material and Methods Mollusk specimens were obtained by sampling during July 2007 and May 2008 at 4 stations (2 stations from Sinop [Ayancik, Türkeli] and 2 stations from Kastamonu [Abana, Çatalzeytin] chosen at the Middle Black Sea, Abana: 41o58'51"N, 34o00'01"E; Çatalzeytin: 41o57'20"N, 34o11'58"E; Türkeli: 41o56'59"N, 34o20'37"E; Ayancik: 41o56'46"N, 34o34'41"E (Figure). A total of 32 (16 x 2 replicate) samplings were performed with 4 samplings for seasonaly. Sampling at the 4 stations was conducted seasonally at various biotopes at depths of 0.5m – 5m. A spatula or shovel was used to collect specimens from a 20X20 cm area using a quadrate sampling methodology. Sampling was carried out by free or scuba diving. Additionally, the physico-chemical parameters of the sampling stations were measured seasonally from the surface to ~1-2m depth using a WTW 340i multi Set water quality meter (Table). The collected material was fixed in 4% formalin solution to be examined in the laboratory. Species identification was performed according to shell characteristics and several reference sources, including Nordsieck (1968), Cachia et al. (1996, 2001), Graham (1971), Barash and Danin (1992), Butakov et al. (1997), Culha (2004), Dogan (2005). Sabelli et al. (1990, 1992) and Clemam (2008) were followed for the systematic index of the species.

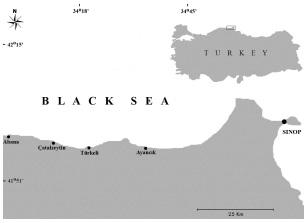


Fig. 1. The position of four selected stations at Kastamonu and Sinop coasts St. 1) Ayancik, (St. 2) Türkeli, (St. 3) Çatalzeytin and (St. 4) Abana

Results and Discussion The aim of the present study is to determine the marine mollusk species on Kastamonu (Abana, Çatalzeytin) and Sinop (Ayancik, Türkeli) coasts. A total of 27 species was detected: 1 of these species belonged to the class Polyplacophora, 15 belonged to the class Gastropoda and 11 belonging to the class Bivalvia. In previous studies, Pusillina radiata and Heleobia stagnarum (Demirci, 2005); Gibbula adriatica, Hydrobia acuta and Mangelia costata (2), and Abra segmentum were reported as new records for the Black Sea coasts of Turkey. On the other hand, Hemilepton nitidum (Turton, 1822) is one of the new species reported for Molluscan fauna from Turkey (3). Previous studies carried out in Sinop peninsula and neighbouring areas analyzed in different biotopes. Demirci and Katagan (2004), collected the samples from rocky substrates and reported 23 species in Ulva facies. Çulha et al. (2000) carried out several studies in sandy bottoms of the same area, but the same authors found 8 species that were not reported by Demirci (2005). Similarly, Çulha (2004) reported 28 Gastropoda. Among these, 13 species were not reported during the study performed by Demirci (2005). In study of Öztürk et al. (2004) from sandy and hard substratum, 26 Bivalvia species were detected. In a deep water study carried out in Inebolu district (Central Black Sea), Luth (2004) found 3 Gastropod and 5 Bivalvia species. Consequently, different results were obtained in previous studies carried out at various periods and localities of the central Black Sea region. This is due to different biotopes, different zones (Supralittoral, infralittoral, mediolittoral etc.), different sampling methods such as grab, dredge, quatrate and different depths. In addition, the utilization of updated publications (e.g. 3Öztürk and Çevik, 2000; 4Clemam, 2008; 5Sabelli et al., 1990, 1992) by researchers who study in this area will reduce potential errors that may arise.

Tab. 1. Minimum and maximum range and Mean ± SD from selected stations, of physicochemical parameters of sea water of Sinop and Kastamonu coasts and analytical procedure during the period July 2007 and May 2008

				St1		St2		St3		St4	
Variables	Abbreviations	Unitz	Analytical method	Mean ±SD	Min-Max	Mean ±SD	Min-Max	Mean ±SD	Min-Max	Mean ±SD	Min-Max
Temperature	Temp	°C	WTW Multi 340i / SET handheld meter	15.67 ± 7.27	7.13 24.73	15.35 ± 6.66	7.72 23.54	14.72 ± 6.22	7.65 22.51	15.69 ± 6.32	9.26 24.19
Salinity	Salint	‰ (ppt)	WTW Multi 340i / SET handheld meter	17.35 ± 0.80	16.21 18.10	17.55 ± 0.82	16.80 18.45	18.40 ± 0.65	17.52 19.02	17.56 ± 1.32	16.09 19.22
pH	pH	µS cm-1	WTW Multi 340i / SET handheld meter	7.58 ± 1.04	6.14 8.57	8.13 ± 0.73	7.15 8.51	7.85 ± 0.73	6.79 8.46	8.03 ± 0.70	7.09 8.73
Amount of Oxygen	DO	mg l-1	WTW Multi 340i / SET handheld meter	6.39 ± 0.64	5.59 7.02	6.12 ± 0.53	5.43 6.71	6.38 ± 0.39	6.00 6.89	6.43 ± 0.62	6.01 7.35
Conductivity	EC	µS cm-1	WTW Multi 340i / SET handheld meter	24.55 ± 0.75	23.72 25.30	24.54 ± 1.07	23.17 25.62	24.00 ± 1.26	22.86 25.41	24.33 ± 0.85	23.12 25.00

References

1 - Zaitsev Yu. P., 2006. Severo-zapadnaya chast' Chernogo morya: biologiya i ekologiya/ Red. i dr. K.: Naukova dumka press, 701 p.

2 - Culha, M., 2004.Taxonomical and Ecological Characteristics of Prosobranchia (Mollusca-Gastropoda) Species Distributed around Sinop, PhD thesis, Aegean University, Izmir, 150 p.

3 - Ozturk, B., Culha M. and Urkmez, D., 2004. Bivalvia Fauna of the Sinop Peninsula and its vicinity, 1st National Malacology Congress (with International Partipication), 1-3 September 2004, Izmir, Turkey, 71-80 pp.

4 - Clemam., 2008. Unitas Malacologica Check List of European Marine Mollusca, Internet site (current URL:http://www.mnhn.fr/base/malaco.html), Réalisé par J. Le Renard, B.I.M.M., M.N.H.N, Paris.

5 - Sabelli, B., Giannuzi-Savelli R. and Bedulli, D., 1990. Catalogo Annotato dei Molluschi Marini del Mediterraneo, *Libreria Naturalistica Bolognese*, 1, 1-348 pp.

DEMERSAL ICHTHYOFAUNA OF THE CENTRAL AEGEAN SEA: DECLINING TRENDS IN SPECIES RICHNESS

Dimitrios Damalas [1] and Vassiliki Vassilopoulou [1]*
[1] Hellenic Centre for Marine Research - celia@ath.hcmr.gr

Abstract
Data collected from 462 commercial bottom trawl hauls in the central Aegean Sea, during 1995-2006, indicated that species richness of the local ichthyofauna has significantly decreased. It is most likely that while the fishery was driven by the most resilient target species, at the same time it had a dramatic effect on numerous other less robust species. Our findings identified certain warning signs reflecting ecosystem degradation and further study through longer monitoring will contribute to the clarification of trends.
Keywords: Aegean Sea, Biodiversity, Fisheries

Introduction
The bottom trawl fishery represents some 20% of the total marine production in Greece with almost 45% of the catch being usually discarded at sea [1]. In order to estimate the long-term impact of commercial fishing on the ichthyofauna diversity of the central Aegean Sea, 462 records of bottom trawl hauls were collected on board commercial vessels between 1995 and 2006 (2001-2002 excluded).

Material and Methods
Fish species identification was done on board by trained scientific personnel, who did not interfere with the normal fishing practices of the crew. An annual biodiversity index was constructed by calculating the number of species by year, in 1000 repetitions of randomly selected predefined number of hauls, so that to exclude spatial and effort effect in the biodiversity trend [2]. The annual trend was then expressed by the slope of a linear regression when regressing number of species upon year.

Results and Discussion
Overall, a total of 171 species were recorded (138 bony and 33 cartilaginous fish), belonging to 79 families and 28 orders [Table 1]. More than three quarters of the bony-fish species encountered were perch-likes (Perciformes), flatfish (Pleuronectiformes), cods (Gadiformes) and scorpionfishes (Scorpaeniformes). These were also the groups of fishes exhibiting some of the higher abundances (Catch Per Unit of Effort > 300 individuals per hour of trawling). Skates and rays (Rajiformes) accounted for almost half of the chondrichthyans. Our results revealed that certain species were absent from the catches during the last 4 years of the study; these were the bony-fishes: *Acantholabrus palloni, Anthias anthias, Arnoglossus imperialis, Arnoglossus rueppelli, Argyropelecus hemigymnus, Callionymus risso, Centrolophus niger, Deltentosteus quadrimaculatus, Echelus myrus, Epigonus telescopus, Hymenocephalus italicus, Stomias boa, Spondyliosoma cantharus, Symphurus nigrescens,* and the chondrichthyans: *Centrophorus granulosus, Chimaera monstrosa, Dalatias licha, Myliobatis aquila, Raja circularis, Squatina aculeata, Squatina oculata*.

Tab. 1. Number of species encountered and fishery dependent abundance (CPUE) by family and order taxon

	Order	No of families	No of species	CPUE (number per hour)
Bony-fish	Perciformes	24	59	1577
	Pleuronectiformes	6	16	344
	Gadiformes	8	15	1737
	Scorpaeniformes	4	15	434
	Anguilliformes	4	6	30
	Clupeiformes	2	3	113
	Syngnathiformes	2	3	196
	Myctophiformes	1	3	9
	Stomiiformes	2	2	7
	Zeiformes	2	2	253
	Lophiiformes	1	2	9
	Ophidiiformes	1	2	3
	Tetraodontiformes	1	2	7
	Atheriniformes	1	1	35
	Aulopiformes	1	1	23
	Aulopiformes	1	1	9
	Beryciformes	1	1	35
	Chlorophthalmidae	1	1	367
	Ophidiiformes	1	1	18
	Oplophoridae	1	1	3
	Osmeriformes	1	1	225
	Total	**66**	**138**	
	Order	**No of families**	**No of species**	
Chondrichthyans	Rajiformes	3	15	89
	Squaliformes	4	6	96
	Carcharhiniformes	2	6	89
	Squatiniformes	1	2	1
	Torpediniformes	1	2	7
	Chimaeriformes	1	1	10
	Hexanchiformes	1	1	1
	Total	**13**	**33**	

The observed decline in the number of species caught in the central Aegean in recent years is further illustrated by the negative and highly significant ($P< 0.001$) slope of the linear regression, relating number of fish species encountered with year [Fig. 1], and suggesting that species richness was reducing by an average of 1.83 species per year, during the studied period. Analogous declining trends were also observed for certain phylogenetic indices in the Greek seas [3], and can be accredited to a series of reasons associated to fishing impact on particular vulnerable species and habitats [4], as well as environmental impact and specifically climate change causing the 'tropicalization' of Eastern Mediterranean [5] which exacerbate biodiversity loss. In fact, specific marine species may be more vulnerable to exploitation and/or changing conditions owed to a number of factors such as older age at maturity, lower reproductive rate, poor adaptation capabilities [6].

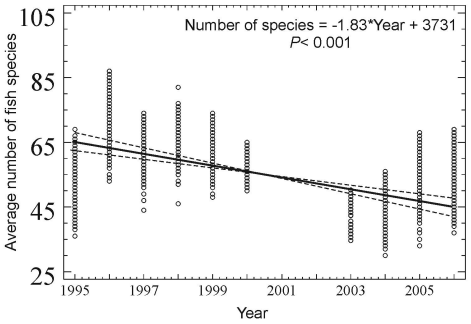


Fig. 1. Annual trend of fish species richness as inferred by a linear regression of Average number of species upon Year

Hence, although our findings identified certain warning signs reflecting ecosystem degradation, further study through longer monitoring will contribute to the clarification of trends.

References
1 - Machias, A., Vassilopoulou, V., Vatsos, D., Bekas, P., Kallianiotis, A., Papaconstantinou, C. and Tsimenides, N., 2001. Bottom trawl discards in the northeastern Mediterranean Sea. *Fisheries Research*, 53: 181-195.
2 - Daan, N., Heessen, H. and ter Hofstede, Remment., 2005. North Sea Elasmobranchs: distribution, abundance and biodiversity. ICES-CM 2005/N:06. Theme Session on Elasmobranch Fisheries Science. 15 pp.
3 - Vassilopoulou, V., Machias, A., Tsagarakis, K., 2007. By-catch and discards in multi-species fisheries and their impact in the Hellenic waters. In: SoHelFI, 2007. State of Hellenic Fisheries. C. Papaconstantinou, A. Zenetos, V. Vassilopoulou & G. Tserpes (Eds), HCMR Publ., 466 pp.
4 - Sacchi, J., 2008. The use of trawling nets in the Mediterranean. Problems and selectivity options. Options Mediterraneennes B (62): 87-96.
5 - Lefkaditou, E., Peristeraki, P., Zenetos, A. and Politou, C.Y., 2008. Climatic effects on marine environment and species expansion in the eastern Mediterranean Sea. Effects of climate change on the World's Oceans. International Symposium May 19-23, 2008, Gijon, Spain, Poster ID: W2&W3- 4987.
6 - Myers, R.A., Ottensmeyer, C.A., 2005. Extinction Risk in Marine Species. In: Norse, E.A. and L.B. Crowder, eds. Marine Conservation Biology: The Science of Maintaining the Sea's Biodiversity. Island Press, Washington DC (USA).

BIOLOGY OF *CALLISTA CHIONE* (L., 1758) IN THERMAIKOS GULF (N AEGEAN SEA)

Panagiotis Damianidis [1]*, Paraskevi K. Karachle [1] and Chariton-Charles Chintiroglou [1]
[1] Aristotle University of Thessaloniki, School of Biology, Department of Zoology, Box 134, 54124, Thessaloniki, Greece - damian@bio.auth.gr

Abstract
The biology of smooth callista [*Callista chione* (Linnaeus, 1758)] was explored from two sites in Thermaikos Gulf, N Aegean Sea. L infinity, K and total mortality were found to be higher in Platamonas (81.38, 1.4, and 2.6474, respectively) compared to those from Sani (76.13, 0.66, and 1.174, respectively). No significant differences were found in the condition index (range: 43.95-51.67), both between stations and seasons.
Keywords: Bivalves, Growth, Mortality, Biometrics, Aegean Sea

Introduction
Smooth callista [*Callista chione* (Linnaeus, 1758)] is commercially exploited throughout the range of its distribution in the Mediterranean. In Greece, despite its great importance, the information regarding its biology is limited (Evvoikos Gulf: [1], Thasos Island: [2]). In the present study, the biology of smooth callista was examined in Thermaikos Gulf. This research was conducted in the framework of a research project (Operational Programme for Fisheries Sector 2000-2006).

Materials and methods
Seasonal samples (spring 2007-winter 2008) were collected from professional fishers (divers with constant air supply), from two different sites in Thermaikos Gulf, Sani (N40° 07,509' E23° 18,149') and Platamonas (N39° 56,741' E22° 42,888'). Shell length (L, in mm) and total weight (W, in 0.1 g) were measured and related using the allometric model $W=aL^b$ [3]. The slopes of the seasonal regressions were compared using analysis of covariance (ANCOVA, [4]). For the estimation of growth parameters L_{inf} (length infinity) and K, and total mortality, FISAT II software [5] was used. Condition index (CI) was estimated as follows [6]:

$$CI=[MW/(W-SW)]*100$$

where MW= net body weight and SW= shell weight. CI values were compared using two-way ANOVA and Fisher's least significant difference (LSD) test [4].

Tab. 1. Parameters of the von Bertalanffy equation (L_{inf}= length infinity, in mm; K=parameter of the von Bertalanffy growth function (also known as growth coefficient; in yr^{-1}), total mortality (Z) and seasonal values of condition index (mean value±standard deviation) for *Callista chione*, Thermaikos Gulf, Greece.

Parameter		Platamonas	Sani
Length range (in mm)		47.31-75.28	29.53-73.02
Weight range (in g)		20.76-104.64	5.99-97.87
L_{inf} (in mm)		81.38	76.13
K (in yr^{-1})		1.4	0.66
Z		2.6474	1.1740
Condition index	Spring 2007		49.77±3.39
	Summer 2007	43.95±7.51	
	Autumn 2007	45.45±7.96	47.95±16.33
	Winter 2008	51.67±2.15	49.84±3.51

Results and Discussion
Overall, 319 individuals (140 from Platamonas and 179 from Sani) were examined. Shell length range was 47.31-75.28 mm in Platamonas, and 29.53-73.02 mm in Sani (Table 1). Seasonal length-weight relationships were all significant ($p<0.01$, $R^2>0.71$; Fig. 1). The values of b of the relationships ranged from 2.7431 to 3.5548 (3.0063±0.28), whereas no significant differences in their values with season and between the two sites (ANCOVA: all cases $p>0.05$) were found. The von Bertalanffy growth parameters (L_{inf} and K), as well as total mortality (Table 1) were highest in Platamonas than in Sani. L_{inf} values in the study area are similar to those from Evvoikos Gulf (L_{inf} = 93mm, [1]) and higher than that from Thasos (L_{inf} = 57.8 and 62.7 mm, [2]). Additionally, K values were found to be higher than any previously reported ones from Greek waters ([1]: Evvoikos Gulf. 0.24, [2]: Thassos island, 0.24 & 0.26), indicating that the species in the study area shows very high growth rate. This could be attributed mainly to the environmental conditions prevailing in Thermaikos Gulf [7]. This species is known to have a fast growing rate in its first years of life, a rate that is progressively reduced [8]. CI ranged from 43.95 to 51.67 (Table 1). Two-way ANOVA revealed that CI values were not affected by sampling site (F-value= 0.02, p=0.8992) and season (F-value= 1.51, p=0.2221). In addition,Fisher'sLSD showed no differences between the two sites and seasons. The fact that no spatiotemporal differences in CI values were found could be mainly attributed to the reproduction cycle of the species. In general, spawning is prolonged from spring till the beginning of winter [1]. Given that our samples were collected during spawning season, no differences were anticipated.

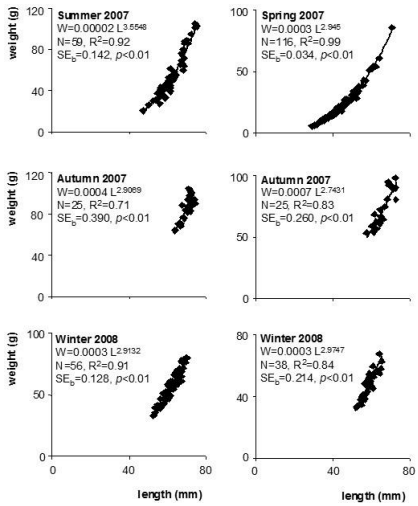


Fig. 1. Seasonal length-weight relationships for *Calliste chione*, in Platamonas (left) and Sani (right), Thermaikos Gulf, Greece

References
1 - Metaxatos A., 2004. Population dynamics of the venerid bivalve *Callista chione* (L.) in a coastal area of the Eastern Mediterranean. *J. Sea Res.*, 52: 293-305.

2 - Leontarakis P.K. and Richardson C.A., 2005. Growth of the smooth clam *Callista chione* (Linnaeus, 1758) (Bivalvia: Veneridae) from the Thracian Sea, northeastern Mediterranean. *J Molluscan Studies*, 71: 189-191.

3 - Lleonart J., Salat J. and Torres G.J., 2000. Removing allometric effects of body size in morphological analysis. *J. theor. Biol.*, 205: 85-93.

4 - Zar J.H., 1999. Biostatistical analysis. 4th Edition. Prentice Hall, New Jersey, USA.

5 - Gayanilo F.C. Jr, Sparre P. and Pauly D., 2005. FAO-ICLARM Stock Assessment Tools II (FiSAT II). Revised version. User's guide. FAO Computerized Information Series (Fisheries). No. 8, Revised version. Rome, FAO.

6 - Aguirre M.J., 1979. Biologia del Mejillon (*Mytilus edulis*) cultivo de la Ria de Vigo. *Bol. Inst. Esp. Oceanogr.*, 5 (3): 107-160.

7 - Stergiou K.I., Christou E.D., Georgopoulos D., Zenetos A. and Souvermezoglou C. , 1997. The Hellenic Seas: Physics, Chemistry, Biology and Fisheries. *Oceanogr. Mar. Biol. Annual Rev.*, 35: 415-538.

8 - Keller N., Del Piero D. and Longinelli A ., 2002. Isotopic composition, growth rates and biological behaviour of *Chamelea gallina* and *Callista chione* from the Gulf of Trieste (Italy). *Mar. Biol* .,140: 9-15.

SPATIAL DISTRIBUTION OF ICHTHYOPLANKTON IN THERMAIKOS AND CHALKIDIKI GULFS DURING JUNE 2004

Maria Danelli [1], Apostolos Siapatis [2]*, Athanasios Machias [2] and Marianna Giannoulaki [2]
[1] Hellenic Center for Marine Research - siapatis@ath.hcmr.gr
[2] Department of Marine Sciences, University of the Aegean

Abstract
The spatial distribution of fish larvae was studied in Thermaikos and Chalkidiki gulfs during June 2004. Samples coming from the 500-mesh size Bongo net were analyzed and 42 taxa belonging in 29 families were identified. Spatial heterogeneity depended on the combined effects of topography and hydrographic features of the region. Classification of stations into groups established three distinct groups of stations, which basically corresponded to the bathymetry of the study area.
Keywords: Aegean Sea, Ichthyoplankton

Introduction
Marine fish larvae play an important role in understanding the ecology and evolution of fishes and their populations [1]. The interpretation of spatial patterns in the ichthyoplankton involves consideration of many factors pertaining to the biology and early life history of fish species and the environment in which they live and reproduce. A complex suite of environmental factors interacts with the biology of fish populations at different temporal and spatial scales to influence the occurrence, distribution, and abundance of the larvae.

Materials and methods
A grid of 13 stations (Fig. 1) was sampled in 15-20 June 2004, with a 60 cm bongo-net (0.250 and 0.500 mm meshed nets) towed obliquely from just above the sea bottom to the surface (maximum to 200 m). Hydrographic profiles were collected on a denser grid of 42 stations. The early life stages of fishes were sorted and identified into families and species. To define ichthyoplankton assemblages, a hierarchical cluster analysis of a Bray-Curtis similarity matrix calculated between species by ranked larval abundance was performed [2], considering only those species or groups that represented 1% of the total catch.

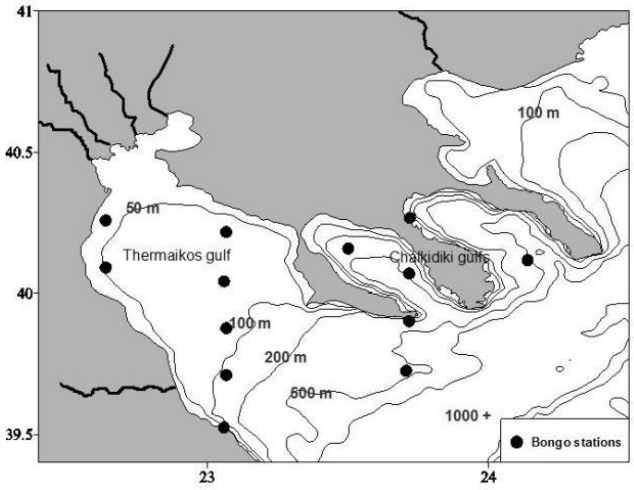


Fig. 1. Map of the study area showing the location of sampling stations

Results and discussion
A total of 3,617 fish larvae were sorted from the 0,500 mm cod-end of the net that were categorized under taxonomy levels of 38 species, 7 genera, and 1 family. European anchovy (28%) composed the highest level in larval distribution and *Sardinella aurita* (14 %) was in the second place. The myctophiids *Ceratoscopelus maderensis* (14%) and *Hygophum hygommii*(10%) were the most abundant mesopelagic taxa. Other taxa caught at high percentages were *Gobiidae* (5%), *Trachurus mediterraneus* (4%), *Serranus. hepatus* (3%), *cepola macrophalma* (3%) and *Arnoglossus sp.* (2%). Using cluster analysis three different groups of taxa were classified (Fig. 2). The first group contains bathypelagic specie/families like *Mychtophidae*, *Sternoptychidae* and *Paralepididae* whereas their larvae caught mainly at the offshore stations of Chalkidiki gulfs. The second group contains neritic species like *Diplodus annularis*, *Coris julis*, *Chromis chromis* and *Symphodus sp.*exhibit an inshore distribution in the coastal band of Thermaikos gulf. Finally, the last group contains taxa characterized by wide dispersal patterns like the pelagic *Engraulis encrasicolus*, *Sardinella aurita*, *Trachurus mediterraneus*, the demersal *Serranus hepatus*, *Gobiidae Cepola macrophalma* and mesopelagic *Ceratoscopelus maderensis* and *Hygophum hygomi* whereas their larvae caught in extremely high densities and distributed over the majority of the sampling stations. The presence of mesopelagic fish larvae over the shelf, occasionally in quite shallow water, therefore, may be the result of some passive mechanism or of shore wards migration by the larvae themselves [3].

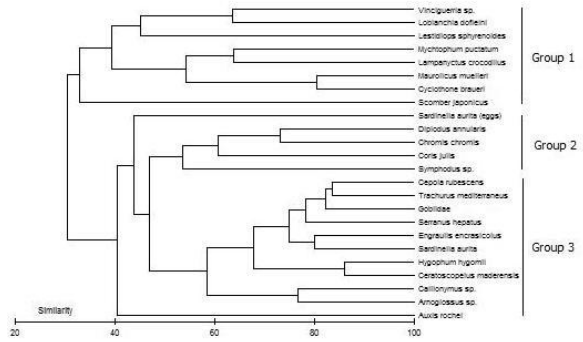


Fig. 2. Dendrogram of similarities (cluster analysis, group-average linkage, fourth root transformation) of the taxa sampled in June 2004

References
1 - Moser, H.G., and P.E. Smith. 1993. Larval fish assemblages and oceanic boundaries. Bull. Mar. Sci. 53: 283-289
2 - Field, G.R., K.R. Clarke and R.M.Warwick. 1982. A practical strategy for analyzing mustispecies distribution patterns. *Mar. Ecol. Prog. Ser.*, 8: 37-52.
3 - Olivar M.P. and Sabates A., 1997. Vertical distribution of fish larvae in the north-west Mediterranean Sea in spring. *Mar. Biol.*, 129: 289-300.

STRUCTURE OF INFAUNAL COMMUNITIES UNDER VARIABLE TRAWLING DISTURBANCE

Silvia De juan mohan [1], Montserrat Demestre [1]* and Pilar Sanchez [1]
[1] Intituto de Ciencias del Mar (CSIC) - montse@icm.csic.es

Abstract
Macroinfaunal communities subjected to different gradients of trawling disturbance were analysed to investigate responses related with trawling effort. Results showed a decrease of abundance and richness with increasing effort, highlighting the benefits of effort restriction to protect marine communities.
Keywords: Biodiversity, Coastal Management, Continental Shelf

Introduction
Fishing activities impacts marine communities and habitats [1], being necessary the incorporation of ecosystem protection in management [2]. We need to gain knowledge on the extent of commercial trawling impact in order to develop actions to reduce disturbance [3]; however pristine areas within trawling grounds are rare, and we have little knowledge about unexploited situations [4]. Aiming to understand the effects trawling intensity on communities we compared the macroinfaunal community at 4 soft bottoms subjected to different regimens of trawling disturbance.

Material and Methods
The 4 sites are located within soft bottoms around 50m depth from the NW Mediterranean. The first study area (A) is located in a fishing ground. This fishing ground includes a portion of undisturbed seabed due to the remains of an abandoned oil platform (area B). The area C is located adjacent to Medes Islands MPA, north from the previous two areas, where occasional trawling takes place. The area D is located inside the MPA where trawling is prohibited. Each area was sampled with a 0.1 m^2 van Veen grab at 5 stations, with 5 grabs randomly collected at each station to obtain the minimum sampling size. Samples were sieved over 1 mm, and organisms were identified to the lowest taxonomical level recording number of individuals. A one-way ANOVA and a Tukey post-hoc test were performed to identify differences between areas.

Results
Abundance is significantly different at all sites ($p>0.01$); being higher at B and D sites (Fig. 1a). Species richness is significantly higher at D ($p>0.001$), whereas it is similar at the other three areas (A, B, C) (Fig. 1b).

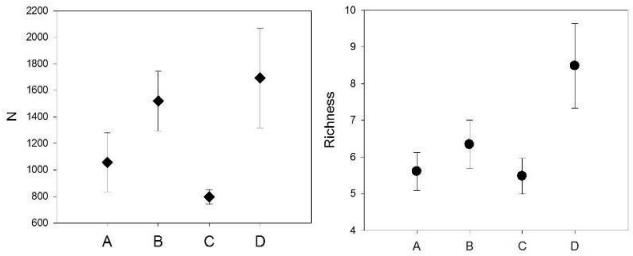


Fig. 1. Abundance and richness (number of species) at the four study areas

70 taxa were collected at area A, 84 at B, 63 at C and 105 at D. Polychaetes is the most abundant group at either area: A, 74%; B, 73%; C 68%; and D 39% (Fig. 2). The second most abundant group at A and B is crustaceans (16%). C holds 6-8% of abundance of each of the groups crustaceans, bivalvia, sipunculida and cnidaria; and D: 26% of sipunculida, 13% bivalvia, 8% crustacean and 6% ophiurids.

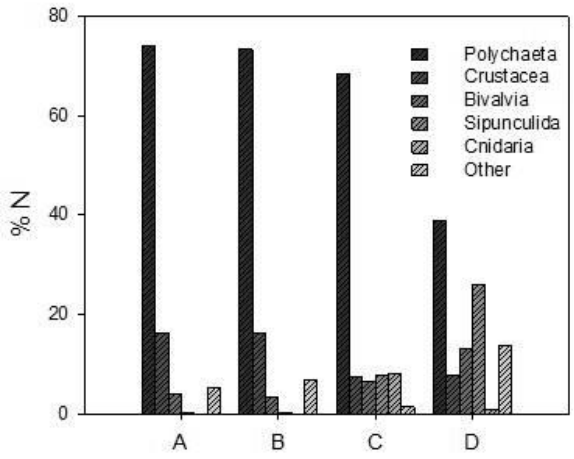


Fig. 2. Percentage of taxonomic groups at the four study areas

Discussion
Trawling reduces the faunal abundance by eliminating the most vulnerable organisms [4]. This pattern is observed in the results with higher abundance at both the MPA and the undisturbed area within the fishing ground. Moreover, trawling might reduce the species richness by increasing dominance of opportunists and species with low vulnerability to trawling [1]. Our results agree with this as the MPA holds higher richness. The four communities are dominated by polychaetes, however the MPA presents lower dominance with higher abundance of other groups. The less disturbed areas maintain more structured communities, suggesting that trawling intensity must be reduced to protect marine habitats from degradation [3, 4].

References
1 - Kaiser M., Ramsay K., Richardson C., Spence F., Brand A., 2000. Chronic fishing disturbance has changed shelf sea benthic community structure. *J. An. Ecol*. 69:494-503.
2 - Frid C., Paramor O., Scott C., 2005. Ecosystem-based fisheries management: progress in NE Atlantic. *Mar. Pol.* 29:461-469.
3 - Turner S., Thrush S., Hewitt J., Cummings V., Funnell G., 1999. Fishing impacts and the degradation or loss of habitat structure. *Fish. Man. Ecol.*6:401-420.
4 - Thrush S., Dayton P., 2002. Disturbance to marine benthic habitats by trawling and dredging: Implications for Marine Biodiversity. *Ann. Rev. Ecol. Syst.* 33:449-473.

EVALUATION OF THE LEVEL OF TRAWLING PERTURBATION ON SOFT BOTTOMS USING ACOUSTIC REMOTE SENSING AS A PROMISING APPROACH FOR FISHING EFFORT ESTIMATION

M. Demestre [1]*, J. Martin [2], C. Mytilineou [3], P. Sartor [4], J. Mas [5], P. Sanchez [1], S. De juan [1], M. Maso [1], P. Martin [1] and C. Lo Iacono [1]

[1] Institut de Ciencies del Mar - CSIC - montse@icm.csic.es
[2] Helenic Center for Marine Research. Athens. Greece.
[3] Centro Interuniversitario di Biologia Marina. Livorno Italy
[4] Instituto Español de Oceanografia. Murcia. Spain
[5] Mediterraneo Servicios Marinos, Alicante Spain

Abstract

Fishing pressure was evaluated using side scan sonar at 5 Mediterranean coasts subjected to different levels of trawling disturbance. The work evidences that trawling effort can be accuratedly estimated using an indirect method. These results have been compared with fishing effort data from commercial fishery and discussed in the context of its implications for management

Keywords: Fisheries, Acoustics, Zoobenthos, Biodiversity

Introduction

Bottom trawling is one of the major sources of damage to the benthos and habitats. Thus, there is an urgent need for developing tools focussed on achieving efficient management of fishing effort and to reduce its impacts [1, 2]. It is difficult to estimate the fishing effort of the trawl fleet both at a small scale and consistent with commertial fishing activities around the wold [3]. Furthermore, this information is essential to analyse both the response of benthic communities and the levels of bottom disturbance in relation with gradients of fishing effort [4]. This study has been developed in the framework of the project COMSOM (CTM2008-04617).

Methods

Five coastal areas located over Mediterranean continental shelves were selected: two in Spain, Cataluña and Murcia coasts, one in Italia, Tyrrhenian coast, and one in Greece, Ionian coast. Each area, that is located between 40 and 70 m depth, subjected to the trawling activity of commercial fishing fleets, and under variable level of fishing effort, were sampled with side scan sonar (SSS) [2]. The images obtained by SSS were analysed by a computer-aided planimetric analysis to determine the density of trawl marks. In a parallel way, information on commercial fishing activity was obtained from data gathered by the fishermen's' association of each selected fishing port.

Results & Discussion

Information on fishing activity and in situ evaluation of the daily activity of the trawl fleet in each coastal area permited the identification of three levels of fishing presure at each area: high, medium and low activity. On the other hand, the densities of trawl marks were estimated by 75 m range sonographs and between 5-7 m above the bottom Both results offer a reliably estimation of the fishing effort at a small scale. The results are presented only in the case of the Ionian coast, as an example. The number of trawlers and GT *hours devoted to fishing activity during the period Oct2008-May2009 suggest 3 sites with different level of fishing activity (Tab1)

Tab. 1. Distribution of fishing effort in three sites of Ionian coast

IONIAN COAST	Site A - Patra Medium effort	Site B - Killini High effort	Site C- Katakolo Low effort
Nº trawlers/year	18	17	11
GT*days/month	10.603	17.255	5.593
Trawl tracks density	23 trawl tracks	39 trawl tracks	13 trawl tracks

The images of SSS follow the same pattern: in a line of 150 m range the number of trawl tracks showed higher number of trawl tracks in site B, less number in site A, and few in site C (Tab.1;Fig 1).

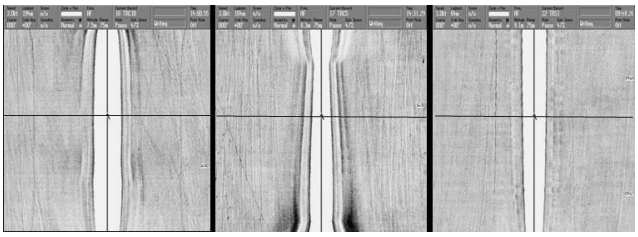


Fig. 1. Trawl marks at the three sites off the Greek Ionian Coats. From right to left: medium, high, and low fishing effort counted along 150m range

From these results we can generalise patterns of trawling disturbance over different habitat types and regions which effort restriction patterns must be applied to reduce benthic ecosystem disturbance [2,4]. The use of indirect methods to adequatedly determine the trawling effort would provide with the potential to develop tools for properly managing fishing activity. In this context, a methodology for determining the level of ecosystem disturbance that can be standardised over different community types would be very useful to allow a comparison of the state of soft-bottom communities from continental shelves.

References

1 - Thrush & Dayton., 2002. Disturbance to marine benthic habitats by trawling and dredging: Implications for Marine Biodiversity. *Annu Rev Ecol Syst* 33: 449-473.

2 - Krost P., Bernhard M., Werner F., Hukriede W., 1990. Otter trawl tracks in Kiel Bay (Western Baltic) mapped by side-scan sonar. *Meeresforsch*, 32:344-353.

3 - Rijnsdorp, A.,Buys A.,Storbeck F., Visser E., 1988. Micro-scale distribution of beam trawls efforts in North Sea between 1993-1996 in relation to trawling frequency of seabed and impact on benthic organisms. *ICES J Mar Sci 55*: 403-419.

4 - Browman H & Stergiou K., 2004. Perspectives on ecosystem-based approaches to the management of marine resources. *Mar Ecol Prog Ser* 274: 269–303.

MARINE SPONGES FROM DATÇA-BOZBURUN PENINSULA - A SPECIALLY PROTECTED AREA IN THE SOUTH EASTERN AEGEAN SEA (TURKEY)

Volkan Demir [1]* and Erdogan Okus [1]
[1] Istanbul University Institute of Marine Sciences and Management - volkandmir@yahoo.com

Abstract
The Sponges were studied at the largest Specially Protected Area (SPA) of Mediterranean basin, Datca Bozburun SPA, in 2002-2004 periods. The samples were collected from all area at depth of 0 to 55 metres both diving by Scuba, freestyle and coastal researchings. As a result, 20 species, belonging to 17 families were found from the Datça Bozburun SPA. One of these taxon is a new record for the Turkish Sponge Fauna (*Ciocalypta carballoi*).
Keywords: Porifera, Eastern Mediterranean

Introduction
Sponges are ecologically and economically important group of marine invertebrates [1]. Each species are an integral part of marine benthic communities with a high-impact role in benthic-pelagic coupling processes [2]. Also Sponges have some of the characteristics of good bioindicators and are convenient tools for characterizing the state of a marine ecosystem [3].

Material and Methods
This study is based on the project "Coastal and Marine Biological Diversity Assessment of Datça-Bozburun Specially Protected Area" [4]. 831 SCUBA and 382 skin dives have been performed in 148 days in 7 cruises to determine the marine biodiversity at the Datça-Bozburun SPA [Fig.1].

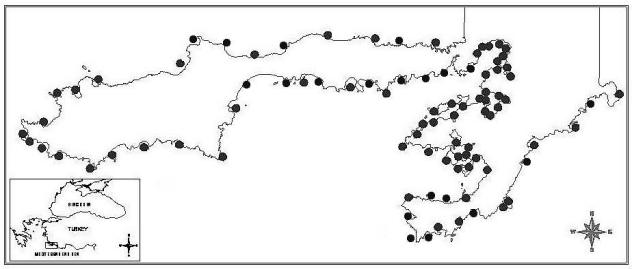


Fig. 1. Location map of the sampling stations

The samples were collected from all area at depth of 0 to 55 metres both diving by Scuba, freestyle and coastal researchings. All sampling stations were situated in the upper infralittoral zone. Samples were fixed by ethanol solution (80%). Following fixation, spicules were isolated by Rützler's standart method and identified to species level.

Results and Discussion
A result of this study, totally 20 species belonging to 17 families were determined from Datça Bozburun Specially Protected Area. These species were as follows: *Sycon raphanus* Schmidt, 1862, *Cliona celata* Grant, 1826, *Spirastrella cunctatrix* Schmidt, 1868, *Suberites domuncula* (Olivi, 1792), *Tethya aurantium* (Pallas, 1766), *Chondrilla nucula* Schmidt, 1862, *Chondrosia reniformis* Nardo, 1847, *Crambe crambe* (Schmidt, 1862), *Axinella cannabina* (Esper, 1794), *Axinella damicornis* (Esper, 1794), *Axinella polypoides* Schmidt, 1862,*Acanthella acuta* Schmidt, 1862, *Ciocalypta carballoi* Vacelet, Bitar, Carteron, Zibrowius & Perez, 2007, *Agelas oroides* (Schmit, 1864), *Haliclona (Reinera) mediterranea* Griessinger, 1971, *Petrosia (Petrosia) ficiformis* (Poiret, 1798), *Calyx nicaeensis* (Risso, 1826), *Sarcotragus foetidus* Schmidt, 1862, *Dysidea avara* (Schmidt, 1862), *Aplysina aerophoba* Nardo, 1843. One of these taxon is a new record for the Turkish Sponge Fauna; descriptive characters of these species is as follows.

Halichondriidae- *Ciocalypta carballoi* Vacelet, Bitar, Carteron, Zibrowius & Perez 2007
The samples were 0,5-8,5 cm high for 3-10 mm basal in diameter. Colour is deep yellow to orange yellow alive, basal incrustation between the papillae, when visible, yellow to yellow green. The spicules are 300-750 × 2,5-15 µm oxeas, most often curved along the whole length. Styles of same size, rare or absent, with intermediates with true oxeas [5].

In study area, rich variety of species have been identified [Fig. 2]. *S. foeditus* and *P. ficiformis* showed the most extensive distribution and all species diversity has a maximum range in Karabük region.

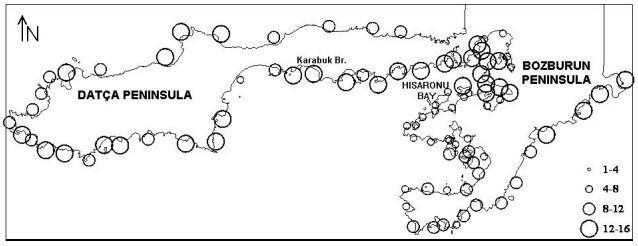


Fig. 2. General distribution of the sponge diversity

This is the first systematical study on sponge fauna in the Datca-Bozburun SPA area. For some areas of the Mediterranean Sea, like those of the Aegean sea, our knowledge on the composition, diversity and abundance of the sponge fauna is limited [6].

Acknowledgements : Authors would like to thank other members of the Oceanos scientific diving team Ahsen Yuksek, Noyan Yilmaz, Asli Aslan Yilmaz, Unsal Karhan, Nazli Demirel, Idil Oz, Umut Tural, Sibel Zeki, Evrim Kalkan for collecting the samples.

References
1 - Hooper, J. N. A. & R. W. M. van Soest., 2002. Systema Porifera. A guide to the classification of sponges. Kluwer Academic/Plenum Publ., New York.
2 - R.W.M. van Soest., 2007., Sponge Biodiversity. *Journal of the Marine Biological Association of the United Kingdom* (2007), 87:6:1345-1348.
3 - Battershill C.N and Abraham R., 1999. Sponges, indicators of marine environmental health. Memoirs of the Queensland Museum 44, 50.
4 - Okus E., Sur H.I., Yüksek A., Yilmaz I.N., Aslan-Yilmaz A., Karhan S.Ü., Öz M.I., Demirel N., Tas S., Altiok H., Müftüoglu A.E., Gazioglu C., Yücel Z.Y., Demir V., Zeki S.& Tural U., 2004. Coastal and Marine Biological Diversity Assessment of Datça-Bozburun Specially Protected Area. Project Final Report, ISBN:975-8273-62-0.
5 - Vacelet J., G Bitar., S Carteron., H Zibrowius and T Perez., 2007. Five new sponge species (Porifera: Demospongiae) of subtropical or tropical affinities from the coast of Lebanon (eastern Mediterranean). *Journal of the Marine Biological Association*, UK 87: 1539–1552.
6 - Kefalas E. and J Castritsi-Catharios., 2007. Taxonomy of some sponges (Porifera, Demospongiae) collected from the Aegean Sea and description of a new species. *Journal of the Marine Biological Association*, UK 87: 1527–1538.

PRELIMINARY RESULTS ON REPRODUCTIVE BIOLOGY OF TRACHURUS MEDITERRANEUS (STEINDACHNER, 1868), IN THE NORTHEASTERN SEA OF MARMARA

Nazli Demirel [1]* and Ahsen Yüksek [1]
[1] Institute of Marine Sciences and Management, Istanbul University - ndemirel@istanbul.edu.tr

Abstract
Mediterranean horse mackerel, *Trachurus mediterraneus*, is one of the most important commercial species in Turkish territorial waters. Results from March to October 2009 show that spawning season of Mediterranean horse mackerel starts at early May and ends at early September in NE part of the Sea of Marmara. Mean GSI values and b parameters show similar variations with synchronized opposition of CF values in monthly results.
Keywords: Reproduction, Fishes, Marmara Sea

Introduction
Trachurus mediterraneus is distributed throughout the Mediterranean, the Black Sea, and the Northeastern Atlantic [1; 2]. Mediterranean horse mackerel is the most abundant commercial fish species after anchovy in the Sea of Marmara [3]. The aim of the present study is to determine the reproductive cycle of the species in the Sea of Marmara. The Sea of Marmara is an enclosed basin where Atlantic-Mediterranean originated commercial pelagic fishes spawn while migrating from the Mediterranean and the Aegean Sea to the Black Sea [4].

Materials and Methods
Samples were obtained randomly from catches of commercial fishing vessels from March to October 2009, caught from 60 to 100 m depths. A total of 523 specimens (232 males, 230 females) were measured. Body weight (W) and total length (TL) were measured (W to the nearest 0.1 g and TL to the nearest mm), to analyse the length–weight relationship. Sex was determined macroscopic aspect of gonads. Gonads of all specimens were dissected and weighed to the nearest 0.001 g in order to calculate the gonosomatic index (GSI).
In addition for further analysis: 1-) Gonads were fixed in 10% buffered formaldehyde solution for determining batch and annual fecundity estimation and histologic studies [5], 2-) Otoliths were sampled for age determination, 3-) Water salinity and temperature profiles were recorded by a CTD system prior to the water quality monitoring project in the northeast part of the Sea of Marmara.

Results
Total length ranged from 11,3-22,5 cm (Fig. 1). The mean GSI reached its maximum values in June and July. Studies on macroscopic aspects of gonads indicated that mature specimens (stage IV in VI maturity classes) were over 11.3 cm for males and 11.7 cm for females (TL).

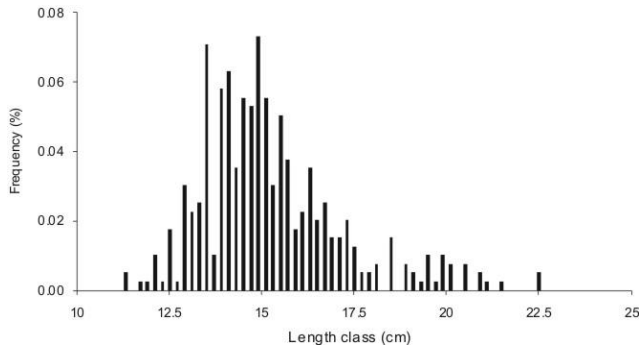


Fig. 1. Frequency of length classes

According to mean GSI values (Fig. 2) and macroscopic aspects of gonads reproductive period appeared to last from early May to late September.
Seasonal variations of the parameter *b* for determining the isometric-allometric growth, shows similarities to GSI variations. From April to August positive allometry was determined while negative allometry was observed in March, September and October.

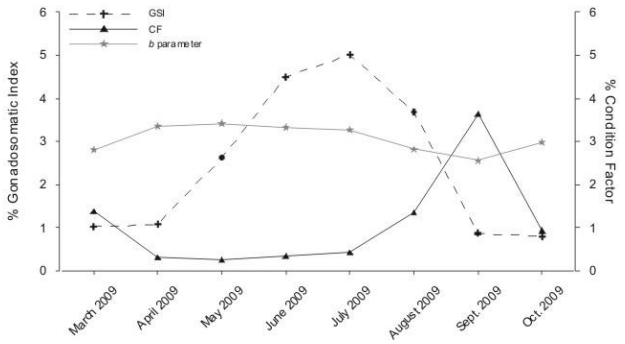


Fig. 2. Monthly variations of mean GSI, CF and *b* parameters value

Discussion
The total length of specimens sampled in northeastern Marmara (11,3 –22,5 cm) does not correspond with the maximum length size up to 50 cm [6; 7]. The lack of bigger specimens could be a characteristic of the local population, overfishing and temperature ranges.
The maximum values of mean GSI were found 5,4% in females in August and 5,2% in males in July. Limited data results are compatible with recent researches on reproductive biology of *T. mediterraneus* in Mediterranean basin [8; 9] although it was reported that values of 10% for mean GSI was common during the reproductive period [8].

References
1 - Tortonese, E., 1975. Osteichtyes (Pesci ossei). In: Calderini (Ed.), Parteseconda, Bologna, 621 pp.
2 - Froese R. and Pauly D., 2003. (Ed.), FishBase.World Wide Web electronic publication. www.fishbase.org
3 - Turkish Statistical Institute, 2008. www.tuik.gov.tr
4 - Kocatas A., Koray T., Kaya M. Aad Kara Ö.F., 1993. A rewiev of the fishery resouces and their environment in the Sea of Marmara. In; Studies and Reviews General Fisheries Council for the Mediterranean, FAO, 64, Roma.
5 - Hunter, J., R., 1985. Preservation of northern anchovy in formaldehyde solution. *In*: Lasker R. (ed.), An Egg Production Method for Estimating Spawning Biomass of Pelagic Fish: Application to the Northern Anchovy, *Engraulis mordax.* NOAA Tecnical Report NMFS 36, December 1985, pp 63-66.
6 - Aksiray F., 1987. Turkiye Deniz Baliklari ve Tayin Anahtari, Kardesler Basimevi, Istanbul, pp 374-380.
7 - Fisher W., Schneider M. and Bauchot M. L., 1987. Fiches FAO d'identification des espèces pour les besoins de la pêche. Mediterranée et Mer Noire, zone de pêche 37. ONU pour l'alimentation et l'agriculture, Rome, 2: 1009–1029.
8 - Viette M., Giulio P. and Ferrero, E. A., 1997. Reproductive biology of *Trachurus mediterraneus* (Teleostei, Carangidae), from the Gulf of Trieste. *ICES Journal of Marine Sciences*, 54: 267-272.
9 - Santic M., Pallaoro A. and Jardas I., 2006. Co-variation of gonadosomatic index and parameters o length-weight relationships of Mediterranean horse mackere, Trachurus mediterraneus, (Steindachner, 1868), in the eastern Adriatic Sea. *J. Appl. Ichthyol*. 22, 214-217.

MATURITY AND REPRODUCTIVE CYCLE OF THE COMMON GUITARFISH, RHINOBATOS RHINOBATOS (LINNAEUS, 1758), IN ISKENDERUN BAY (NORTHEASTERN MEDITERRANEAN)

Sefa ayhan Demirhan [1], Sehriban Çek [1], Asiye Basusta [2] and Nuri Basusta [2]*
[1] Mustafa Kemal University, Fisheries Faculty, Iskenderun -Hatay Turkey
[2] Firat University Fisheries Faculty, Elazig Turkey - nbasusta@hotmail.com

Abstract
In this study, maturity and reproductive cycle of *R. rhinobatos* was investigated in the Iskenderun Bay. Lengths at 50% maturity were 70.0 cm for males, and 86.0 cm for females. In the 2005 breeding season, there was one major period of spawning which lasted approximately 3 months, from April to July. In November and December, gonads of females were almost empty. The peak GSI was recorded in May (4.29 ±1.19 g) for females and in November (1.97 ±0.148 g) for males. Hepatosomatic index (HSI) was found to fluctuate widely in males and females. The annual HSI cycle in female *R. rhinobatos* begins with an increase in liver weight in January and February just prior to maximum GSI levels in May, followed by a decrease in September, October and November at the onset of mating.
Keywords: Fisheries, Fishes, Reproduction, Eastern Mediterranean

Introduction
Elasmobranches are generally long-lived with long gestation period, low fecundity and late maturity that make them susceptible to over fishing [1;2]. *R. rhinobatos* is an ovoviviparous fish having a gestation period of about nine months and a mean reproductive rate of 8 to 14 progeny per pregnancy [3]. If shark, skate and ray fishing is to be sustainable, management must be driven by the biological capacity of the sharks themselves. This will require better knowledge of the biology, ecology and the life history of the populations being exploited, and of rarer species that may be taken as bycatch [4]. The aim of this study was to investigate and gain additional information on the maturity and reproductive cycle of *R. rhinobatos* in Iskenderun Bay.

Material and Methods
A total of 114 common guitarfish were caught and examined. Fish ranged in size from 41 to 146 cm (TL). The sizes at 50% maturity for male and female *R. rhinobatos* were 70 cm and 86 cm in TL respectively (Figure 1). The GSI and the HSI were estimated from 114 specimens, measuring between 41 and 147 cm in total body length, sampled during the study period.

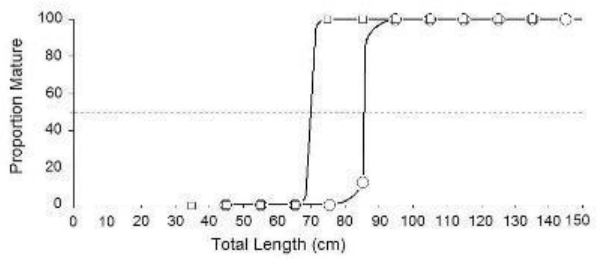


Fig. 1. Proportion of maturity against total length (cm) for males ([]) and females (O)

Results and Discussion
Results of the GSI and HSI calculations for females and males, from January 2005 to December 2005 are represented in Figure 2a, b. The peak GSI was recorded in May (4.29 ±1.19 g) for females and in November (1.97 ±0.148 g) for males. An increase in the average value of this index is interpreted as beginning of sexual maturation, while a sudden drop in this index is indicative of a spawning event. Changes in GSI in females and males did not follow a similar pattern during gametogenesis in *R. rhinobatos*. This founding is similar to that reported for other elasmobranches species, e.g. [5]. *R. rhinobatos* seems to spawn during the spring season as the GSI of females was the highest in May. As vitellogenessis proceeds in female *R. rhinobatos* GSI increases to a peak in May while HSI declines. This decline in HSI, continue throughout gestation (March, April, May, June) recovering to pre-ovulatory levels after parturition. This means that, *R. rhinobatos* devotes the resources to gonadal development. Hepatosomatic index was found to fluctuate widely in males and females. Similar fluctuations in female HSI are reported for the lesser sand shark, *Rhinobatos annulatus* [6] and spiny dogfish, Squalus acanthias [7]. Seasonal variation in HSI of the *R. rhinobatos* has been attributed to fluctuations in lipid content of the liver, which has been correlated with reproductive condition in female lesser sand shark *R. annulatus* [8]. The pattern of HSI was not consistent in female and male *R. rhinobatos* over the reproductive cycle may indicated that liver reserves (such as lipids and proteins used for oocytes growth) were stored and metabolised during different times of the reproductive cycle. This is in agreement to other ovoviviparous species such as *D. sabina* [5] and spiny dogfish, *Squalus acanthias* [7]. In elasmobranches, males and females are not sexually mature at the same size [8;9]. This knowledge is supported by the observation that, females matured lager sizes than males in this study. In addition the length at first maturity of *R. rhinobatos* in the recent study were similar for both males and females in some previous studies. The present result showed that, total body length ranged from 72 to 89 cm in 10 specimens, in which clasper lengths (mean 6.0 cm, ±1.13) were smaller than expected clasper length (mean 10.3 cm, ±0.67) in 5 specimens (total body length ranged from 71 to 89 cm) in the same length groups. It has suggested that, smaller clasper length in large specimens was not a sign of hermaphroditism, but was a sign of late maturity [10].

References
1 - Stevens, J.D., Bonfil, R., Dulvy, N. and Walker, P. 2000. The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems. ICES Journal of Marine Science, 57: 476–494.
2 - Marquez-Farias J.F. 2007. Reproductive biology of shovelnose guitarfish Rhinobatos productus from the eastern Gulf of California Mexico. Mar Biol. 151: 1445–1454.
3 - Abdel-Aziz, S.H., Khalil, A.N. and Abdel-Maguid, S.A. 1993. Reproductive cycle of the common guitarfish, *Rhinobatos rhinobatos* (Linnaeus, 1758), in Alexandria waters, Mediterranean Sea. Australian Journal of Marine and Freshwater Research 44:3: 507– 517.
4 - Camhi, M., Fowler S., Musick, J., Brautigam, A. and Fordham, S. 1998. Sharks and Their Relatives: Ecology and Conservation. Occasional Paper of the IUCN Species Survival Commission. No: 20.
5 - Maruska, K.P., Cowie, E.G. and Tricas, T.C. 1996. Periodic gonadal activity and protracted mating in elasmobranch fishes. J. Exp. Zool., 276: 219-232
6 - Rossouw, G. J. 1987. Function of the liver and hepatic lipids of the lesser sand shark, Rhinobatos annulatus (Müller & Henle). Comparative Biochemistry and Physiology, 86B: 785-790.
7 - Demirhan, S. A. and Seyhan, K. 2006. Seasonality of Reproduction and Embryonic Growth of Spiny Dogfish (Squalus acanthias L., 1758) in the Eastern Black Sea. Turk. J. Zool. 30: 433-443.
8 - Capape, C. and Zaouali, J. 1981. Etude du regime alimentaire de deux Selaciens communs dans le golfe de Gabes (Tunisie): *Rhinobatos rhinobatos* (Linne, 1758) et *Rhinobatos cemiculus* (Geoffroy Saint-Hailaire 1817), Archs. Inst. Pasteur Tunis. 56: 285–306.
9 - Capape, C. and Zaouali, J. 1994. Distribution and reproductive biology of the blackchin guitarfish, *Rhinobatos cemiculus* (Pisces: Rhinobatidae) in the Tunisian waters. Aust. J. Mar. Freshwater Res. 45: 551-561.
10 - Çek, S., Basusta,N., Demirhan, S.A. and Karalar, M. 2009. Biological observations on the common guitarfish Rhinobatos rhinobatos from Iskenderun Bay (Turkey, Eastern Mediterranean). Animal Biology (59) 211-230..

REPRODUCTION DU SAR TAMBOUR *DIPLODUS CERVINUS CERVINUS* (SPARIDAE) DES COTES DE L'EST ALGERIEN

Farid Derbal [1]* and Mohamed Hichem Kara [1]

[1] Laboratoire bioressources marines, Université Badji-Mokhtar, Annaba, Algérie - mfderbal@yahoo.fr

Abstract

Divers aspects de la reproduction du sar tambour *Diplodus cervinus cervinus* (Lowe, 1838) sur les côtes de l'Est de l'Algérie sont abordés. La valeur moyenne annuelle du sex-ratio (29,12%) est en faveur des femelles. La fraction hermaphrodite reste insignifiante et ne représente que 2% de la population échantillonnée. Cette espèce se reproduit entre mars et août, à partir d'une longueur totale de 25 cm.

Keywords: Algerian Basin, Fishes, Reproduction, Teleostei

Introduction

Malgré l'étendue de son aire de répartition dans les eaux atlantique et méditerranéenne, le sar tambour *Diplodus cervinus cervinus* (Lowe, 1838) est rarement signalé ou est absent des inventaires ichtyologiques. Les informations sur sa biologie et son écologie sont éparses [1], [2]. En Afrique du Nord, seuls Derbal et Kara [3] se sont intéressés à son régime alimentaire. Nous fournissions ici des données nouvelles sur sa reproduction sur les côtes de l'Est de l'Algérie.

Matériel et méthodes

Ce travail a été réalisé sur 230 individus de longueurs totales comprises entre 9,8 et 52,7 cm. Les poissons ont été pêchés mensuellement entre janvier et décembre 2001. Le sex-ratio a été exprimé par la relation suivante: SR = (nombre de mâles / nombre total) x 100. L'écart des valeurs observées du sex-ratio par rapport à la proportion théorique 50 % a été déterminé par un test de khi-deux [4]. Le sex-ratio a été d'abord établi pour la population globale, puis en fonction du développement ontogénétique et des saisons de capture. La période de reproduction a été déterminée d'après les variations mensuelles du rapport gonado-somatique (RGS). La taille à la première maturité sexuelle correspond à la taille à laquelle 50% des individus sont matures et présentent des gonades développées (stade III de l'échelle de Buxton) [5].

Résultats

La population échantillonnée de *D. cervinus cervinus* est structurée de la manière suivante: juvéniles (26,38%), mâles (20,83%), femelles (50,69%) et hermaphrodites (2%). Avec une valeur annuelle moyenne de 29,12%, le sex-ratio n'est pas différent de la proportion théorique 50% (χ^2= 2,22; $P \leqslant 0,05$). Le tableau 1 indique les variations saisonnières du sex-ratio. D'une manière générale, les femelles dominent numériquement dans les prises au cours des quatre saisons ($22,72 \leqslant SR \leqslant 33,33\%$; $P \leqslant 0,05$). L'évolution ontogénétique du sex-ratio montre que la proportion des femelles domine nettement dans les catégories de taille comprises entre 20 et 50 cm (52,63 - 100%). En revanche, les mâles sont plus nombreux au-delà d'une longueur totale de 50 cm (83,3%). Le suivi mensuel du rapport gonado-somatique (Fig. 1) permet de situer la période de reproduction entre mars et août. La longueur totale des poissons à leur première maturité sexuelle est de 25 cm. L'intervalle de maturité sexuelle (I_m) relatif à cette taille est compris entre 21,5 et 27 cm.

Tab. 1. Variations saisonnières du sex-ratio chez *Diplodus cervinus cervinus* des côtes de l'Est algérien. - : test statistique non applicable (effectif inférieur à 5) ; * : significatif au risque d'erreur 5% ; n.s : non significatif

Saisons	Sexe		Sex-ratio (%)	Khi-deux $_{obs}$
	Males	Femelles		
Hiver	04	13	23,52	-
Printemps	15	31	32,6	5,56 *
Eté	05	17	22,72	6,54 *
Automne	06	12	33,33	2 n.s

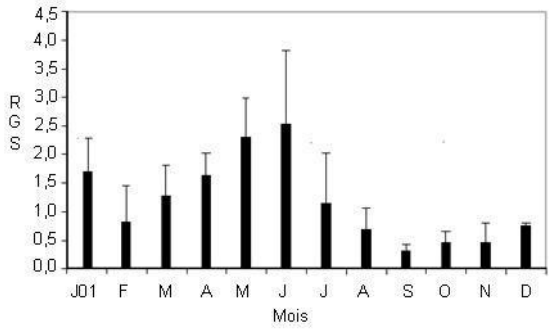


Fig. 1. Evolution mensuelle du RGS et période de reproduction de *Diplodus cervinus cervinus* des côtes de l'Est algérien

Discussion

Dans l'Est algérien, *D. cervinus cervinus* se reproduit entre le printemps et l'été, à partir d'une longueur totale de 25 cm, comme dans l'archipel des Canaries où cette espèce se reproduit à partir de 26 cm pour les mâles et de 22 cm pour les femelles [2]. Chez *D. cervinus hottentotus* des côtes de l'Afrique du Sud, cette taille de première maturité sexuelle est de 28 cm [6]. La population que nous avons échantillonnée est dominée nettement par des femelles avec une fraction hermaphrodite négligeable. L'insuffisance des effectifs dans les classes de taille limites (petits et grands) ne permettent pas de préciser la stratégie reproductive empruntée par le sar tambour sur les côtes Est de l'Algérie. Dans l'archipel des Canaries, *D. cervinus cervinus* est hermaphrodite protogyne et son sex-ratio est aussi en faveur des femelles (1 : 2,16) [2], alors que sur la côte Sud-est du Cap (Afrique du Sud), la proportion relative des deux sexes chez la population de *D. cervinus hottentotus* ne présente pas de différence significative par rapport à 1 (χ^2= 1,15; $P > 0,05$) [6].

References

1 - Pajuelo J.G., Lorenzo J.M. and Dominguez-Seoane R., 2003 a. Age estimation and growth of the zebra seabream *Diplodus cervinus cervinus* (Lowe, 1838) on the Canary Islands shelf (Central-east Atlantic). *Fish. Res.*, 62: 97-103.

2 - Pajuelo J.G., Lorenzo J.M., Dominguez-Seoane R., Ramos A. and Gregoire M., 2003 b. On the population ecology of the zebra seabream *Diplodus cervinus cervinus* (Lowe, 1838) coast of the Canarian archipelago, North West Africa. *Env. Biol. of Fishes*., 67: 407-416.

3 - Derbal F. and Kara M.H., 2006. Régime alimentaire du sar tambour *Diplodus cervinus cervinus* (Sparidae) des côtes de l'est algérien. *Cybium*, 30: 161-170.

4 - Dagnelie, P., 1975. Théorie et méthodes statistiques. 2: les méthodes de l'inférence statistique. Les presses agronomiques de Gembloux. 451 p.

5 - Buxton C.D., 1990. The reproductive biology of *Chrysoblephus laticeps* and *C. cristiceps* (Téléostéens, Sparidae). *J. Zool., Lond*., 20: 497-511.

6 - Mann B.Q. and Buxton C.D., 1998. The reproductive biology of *Diplodus sargus capensis* and *D. cervinus hottentotus* (Sparidae) off the South-East cap Coast South Africa. *Cybium*, 228: 31-47.

PRELIMINARY DATA ON A NEW STRAIN OF *ARTEMIA* (CRUSTACEA, BRANCHIOPODA) FROM EL-BAHIRA LAKE (NORTHEAST ALGERIA)

Farid Derbal [1]*, Mounia Amarouayache [1] and M. Hichem Kara [1]
[1] Laboratoire bioressources marines, Université Badji-Mokhtar, Annaba, Algérie - mfderbal@yahoo.fr

Abstract
Artemia from El-Bahira lake (northeast of Algeria) has been studied in point of view of its biometrics, its dynamics and its cyst hatching quality. Adults are only represented by females. Those measure between 9.04 and 12.15 mm length and produce between 3.75 and 18.43 offspring/brood, according to the sampling period. Cyst diameter is 277.26 µm and freshly hatched nauplii are 549.12 µm length. Population density varied during the wet period of 2009 between 12.38 and 107.7 ind.L^{-1}. Hatching percentage of cysts is 63.45 %.
Keywords: Aquaculture, Biometrics, Crustacea, Reproduction, Zooplankton

Introduction
In Algeria, *Artemia* (L., 1819) (Crustacea, Branchiopoda) made the object of some ecological and biological works. The aim of these investigations is to understand the dynamics of the different populations and to check their quality for aquaculture purposes. Three bisexual strains are well known, that of Sebkha Arzew [1], that of Chott Marouane [2, 3, 4] and that of Sebkha Ez-Zemoul [4]. We describe here for the first time an Algerian parthenogenetic population, in point of view of its biometrics, some aspects of its dynamics and its cyst hatching quality.

Materials and Methods
El-Bahira is a seasonal saline lake of 10 ha, situated in the semi-arid high table land of Constantine in the northeast of Algeria (35°50'19"N 05°15'04"E, 1000 m altitude). The salinity varied during the study period between 80 and 120 g.L^{-1}. Samples of *Artemia* have been taken between February and June 2009, using a plankton net of 125 µm mesh vacuum, and fixed in 3 % formalin. Diameter of hydrated cysts has been determined. Adults and freshly hatched nauplii have been measured from the naupliar eye to the anus. Individuals have been counted under a binocular, using Dollfus cells, and gathered, according to their developing stage, into nauplii and metanauplii, juveniles and adults [5]. Cysts have been incubated in standard conditions recognized by [5], after hydrogen peroxide treatment used for diapause's deactivation. Cyst hatching percentage has been determined.

Results and Discussion
Artemia population from El-Bahira lake is represented only by females and should be parthenogenetic. The latter are big in size (Tab. 1) in comparison with bisexual Mediterranean populations [3, 6, 7, 8] and are little fertile (3.75 ± 1.06 and 18.43 ± 9.67 offspring/brood). The oviparity is the dominant mode of reproduction as it is the case for the other Algerian populations (4). That mode occurs when conditions are harsh. Thus, it is a way to unsure the perennial continuity of the species [9]. Hydrated cysts and nauplii are relatively big in size (Tab. 1) [2] and are close to those of parthenogenetic origin [5].

Tab. 1. Biometrics of adults, cysts and nauplii of *Artemia* sp from El-Bahira lake, Algeria (values between parentheses represent the number of observations)

Mean adult's size (mm±S.D)			Mean cyst's	Mean naupli's
February	April	June	diameter (µm± S.D)	size (µm± S.D)
9.06	9.72	12.15	277.26	549.12
±0.83	±1	±1.13	±22.36	±60.32
(88)	(200)	(347)	(100)	(100)

In February 2009 (the beginning of the wet period), nauplii and metanauplii dominated while adults were present at a low percentage (Fig. 1). The same demographical structure was observed in April. In June, adults dominated while nauplii and metanauplii presented less than 10 % of the population. Total density was 63.8 ± 3.22 ind.L^{-1} in February, attained a maximum of 107.7 ± 7.78 ind.L^{-1} in April and decreased to 12.38 ± 1.6 in June. According to [10], a natural density of 100 ind.L^{-1} is considered as very high. Hatching percentage of cysts is 63.45 ± 21.18 %, which should be acceptable of their use in aquaculture.

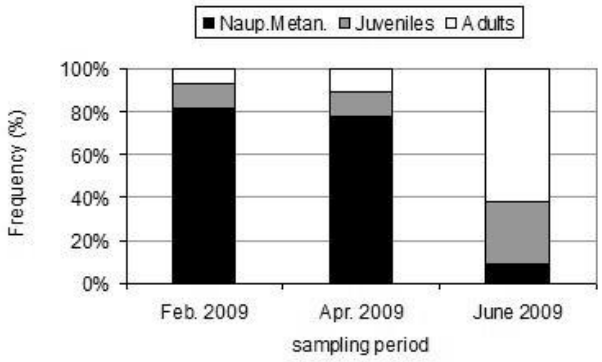


Fig. 1. Frequency of the developing stages of *Artemia* sp from El-Bahira lake, Algeria

References
1 - Haddag M., 1991. Contribution à l'étude d'une souche d'artémia (*Artemia tunisiana*) endémique aux eaux de la saline d'Arzew, Algérie : 68 pp. Thèse de Magistère en Sciences biologiques. Option aquaculture. Institut des Sciences de la Mer et de l'Aménagement du Littoral, Alger, Algérie.
2 - Kara M.H., Bengraïne K.A., Derbal F., Chaoui L., Amarouayache M., 2004. Quality evaluation of a new strain of *Artemia* from Chott Merouane. *Aquaculture*, 235: 361-369.
3 - Amarouayache M., Derbal F. Kara M.H., 2009. Biological data on A*rtemia salina* (Branchiopoda, Anostraca) from Chott Marouane (northeast Algeria). *Crustaceana*, 82 (8): 997-1005 (9). DOI. 10.1163/156854009X452768.
4 - Amarouayache M., 2009. L'*Artemia* dans les Chotts et les Sebkhas du Nord-Est de l'Algérie: recherches sur les populations du Chott Marouane et de la Sebkha Ez-Zemoul. Doctorat thesis, Badji-Mokhtar university, Annaba, Algeria. 120pp.
5 - Sorgeloos P., Lavens P., Leger P., Tackaert W., Versichele D., 1986. Manual for the culture and use of brine shrimp *Artemia* in aquaculture. Pp. 1-319. *Artemia* Reference Center, State of Univ. Ghent, Belgium.
6 - Amat F., 1980. Differentiation in *Artemia* strains from Spain. In: G. Persoone, P. Sorgeloos, O. Roels & Jaspers E. (Eds), The brine shrimp *Artemia*: 19-39 (Universa Press, Wetteren, Belgium).
7 - Mura G., 1993. Seasonal distribution of *Artemia salina* and *Branchinella spinosa* in a saline astatic pond in south west Sardinia Italy (Anostraca). *Crustaceana*, 64 (2): 172-191.
8 - El-Bermawi N., Baxevanis A.D., Abatzopoulos T.J., Van Stappen G., Sorgeloos P., 2004. Salinity effects on survival, growth and morphometry of four Egyptian *Artemia* populations (International study on *Artemia.* LXVII). *Hydrobiologia*, 523: 175-188.
9 - Barata C., Hontoria F., Amat F., 1995. Life history, resting egg formation and hatching may explain the temporal geographical distribution of *Artemia* strains in the Mediterranean basin. *Hydrobiologia*, 298: 295-305.
10 - Lavens P., Leger P., Sorgeloos P., 1986. Production, utilization and manipulation of *Artemia* as food source for shrimp and fish larvae. *Oceanis*, 4: 229-247.

PARASITES OF RED-MED IMMIGRANT AND NATIVE MEDITERRANEAN COASTAL FISH SPECIES: NEW OBSERVATIONS FROM THE ISRAELI AND TURKISH COASTS

A. Diamant [1]*, M. Goren [2], B. S. Galil [3], B. Yokes [4] and Y. Klopman [5]

[1] National Center of Mariculture, Israel Oceanographic and Limnological Research Institute - diamant@ocean.org.il

[2] Department of Zoology, George S. Wise Faculty of Life Sciences, Tel Aviv University, Ramat Aviv, Israel

[3] National Institute of Oceanography, Israel Oceanographic and Limnological Research, Haifa, Israel

[4] Haliç University, Faculty of Arts & Sciences, Department of Molecular Biology & Genetics, Istanbul, Turkey

[5] Department of Zoology, George S. Wise Faculty of Life Sciences, Tel Aviv University, Ramat Aviv, Israel

Abstract

The metazoan parasites of 20 species of invasive and native fish species along the Israeli and Turkish Mediterranean coasts were studied. A total of 648 fish were examined for branchial and alimentary tract parasites. The parasite groups found were Nematoda (25.5% of examined fish), Cestoda (18.7%), Monogenea (15.3%), Digenea (11.9%), Copepoda (7.3%), Isopoda (4.5%) and Acanthocephala (0.5%). The combined prevalence of all taxa was very similar amongst native and invasive species. Although information on the invasive parasite species in their native Red Sea are not as well studied as in their new Mediterranean target area, analysis of our data suggested that the success of invading host populations was not unequivocally linked with reduced parasite loads.

Keywords: Parasitism, Fishes, Eastern Mediterranean, Red Sea, Suez Canal

Introduction

One of the most significant factors to impact the eastern Mediterranean over the last few decades is the massive invasion of tropical Red Sea faunal elements via the Suez Canal.Despite numerous research efforts of this extraordinary phenomenon, we still have relatively little knowledge on the role parasites have in this arena. Several authors have attempted to explain the extraordinary success of some invader species that have created large populations and spread over large areas, while others appear to be limited and only marginally successful. The "Enemy Release Hypothesis" has been suggested as a possible explanation.

Materials and methods

In the present study, we studied the metazoan parasites of 20 species of invasive and native fish species along the Israeli and Turkish Mediterranean coasts. All together, a total of 648 fish were examined for branchial and alimentary tract parasites.

Results

The most prevalent parasite groups were Nematoda (25.5% of examined fish) and Cestoda (18.7%); Monogenea (15.3%) and Digenea (11.9%) were less common, and least abundant were Copepoda, Isopoda and Acanthocephala (7.3%, 4.5% and 0.5%, respectively). The prevalence of all taxa combined was very similar amongst native and invasive species (65.6% and 61.3%, respectively; χ^2 p=0.348). Digenea are a distinctive heteroxenous group of parasites, which possess complex, multiple-host life cycles. Somewhat unexpectedly, no statistically significant difference (p=0.093) was found between their prevalence in invasive (13.1%) and native (8.1%) fish host species.

Overall infection prevalence values were higher in samples taken from the Israeli coast as compared to those taken in Turkey (67.4% vs. 52.7% respectively, p<0.001). This difference may reflect warmer waters prevailing on the Israeli coast that would accelerate parasite development rates and possibly enhance survival of larval stages.

The most abundant invasive fish species in our samples was *Saurida undosquamis* (Synodontidae), which occurred in >80% of the trawl nets. This long established species was heavily infected with larval cestodes (mostly Tetraphyllidae and Trypanorhynchae). It also hosted the digenean *Lecitochirium* cf. *manicaudatus* (Hemiuridae), larval nematodes, Monogenea (Capsalidae) and *Gnathia* sp. (Isopoda). A recent invading species, *Apogon smithi*, which occurred in 35.5% of the trawls, supported a high prevalence (52.1%) of cestodes (mainly Pseudophyllidea and Diphyllidea), as well as an unidentified digenean probably belonging to the Lecithasteridae.

The bluespotted cornetfish, *Fistularia commersonii*, another recent invader species, supported high prevalence infections with larval cestodes and two digeneans, *Allolepidapedon* sp. and *Neoallolepidapedon* sp. (Lepocreadidae). *Allolepidapedon* has recently been reported from bluespotted cornetfish on the Italy coast (Pais et al., 2007). Both lepocreadids are known from cornetfish in the Pacific Ocean and are therefore presumed to be invasive Indo-Pacific species.

The Hemiuroidea were by far the most prominent and speciose digenean sub-order in our samples. These parasites typically have low host specificity and most occupy the stomach, a relatively harsh environment. These group attributes may have facilitated the relatively wide distribution and abundance amongst the invading fish species.

Discussion

Although in recent years we are steadily accumulating knowledge on parasitic infections of the Red-Med species in their new environment, we still lack fundamental data on parasite infections of the invasive species in their native Red Sea. The available information suggests that while parasite richness is reduced upon invasion, abundance levels of some host species fluctuate and the success of invading host populations may not be unequivocally linked with reduced parasite loads.

References

1 - Diamant, A., 1989. Lessepsian migrants as hosts: a parasitological assessment of rabbitfish *Siganus luridus* and *Siganus rivulatus* (Siganidae) in their original and new biogeographical regions.In: Environmental Quality and Ecosystem Stability, Vol. IV-B, Environmental Quality. ISEEQS Pub., Eds: E. Spanier et al., pp. 187-194.

2 - Pasternak Z., Diamant A. and Abelson A., 2007. Co-invasion of a Red Sea fish and its ectoparasitic monogenean *Polylabris* cf. *mamaevi* into the Mediterranean: oncomiracidium behavior and parasite abundance. *Parasitology Research*. 100 (4): 721-727.

MIGRATION OF COMMON SOLE JUVENILES IN COASTAL LAGOONS ASSESSED BY OTOLITH AND STABLE ISOTOPE FINGERPRINTS (NW MEDITERRANEAN)

Jan Dierking [1], Fabien Morat [2], Yves Letourneur [3] and Mireille Harmelin-vivien [2]*

[1] Leibniz Institute of Marine Sciences (IFM-GEOMAR), 24105 Kiel, Germany

[2] Université de la Méditerranée, Centre d'Océanologie de Marseille, UMR CNRS 6540, 13007 Marseille - mireille.harmelin@univmed.fr

[3] Université de la Nouvelle-Calédonie, Laboratoire LIVE, Campus de Nouville, BP R4, 98851 Nouméa Cedex, New Calédonia

Abstract

Stable isotope ratios in muscle (C, N) and otolith (C, O), and otolith microchemistry were analysed in common soles when they entered a coastal lagoon in spring and when they returned to the sea in autumn. Fingerprints of lagoonal life were observed both in muscle and otolith, but were fixed for the whole life of fish in otoliths only.

Keywords: Coastal Systems, Fishes, Migration, Chemical Analysis, Gulf Of Lions

Introduction

In the Gulf of Lions (NW Mediterranean), population dynamics of the common sole, *Solea solea* (L., 1758), are positively correlated to the Rhone River inputs [1]. Juveniles recruit in shallow waters in spring. Part of this population then enters coastal lagoons shortly after recruitment and migrates back to the sea only in autumn [2]. This raises the question how time spent in coastal lagoon nurseries early in the lifespan influences common sole population dynamics. To address this question, we analysed changes in potential fingerprints of lagoonal life (in particular, C, N, and O stable isotope ratios and otolith microchemistry) in sole populations entering and leaving the same coastal lagoon.

Material and Methods

Soles were sampled in Mauguio lagoon in April and May 2004 (n = 47) when they entered the lagoon and in September and November 2004 (n = 42) when they returned to the sea. C and N (dorsal white muscle) and C and O (otoliths) stable isotope ratios were analysed by isotopic mass spectrometry [3] and the microchemistry of their whole otoliths was determined by LA-ICPMS [4].

Results and Discussion

Entering soles measured 10.6 ± 1.2 cm TL. They had doubled their size (20.9 ± 1.0 cm TL) when they left the lagoon in autumn. Muscle C and N stable isotope ratios increased during lagoonal life. The same trend was observed in otolith C and O stable isotope ratios (Fig. 1). Concerning otolith microchemistry, significant changes were oberved for the Sr/Ca, Mg/Ca and Fe/Ca ratios. Sr/Ca was higher in leaving than in entering soles, whereas the reverse was observed for Mg/Ca and Fe/Ca (Fig. 2).

In summary, isotopic and chemical signatures significantly differed in soles leaving Mauguio lagoon in autumn compared to individuals entering in spring. This indicates that the time spent in coastal lagoons left distinct fingerprints in different sole components.

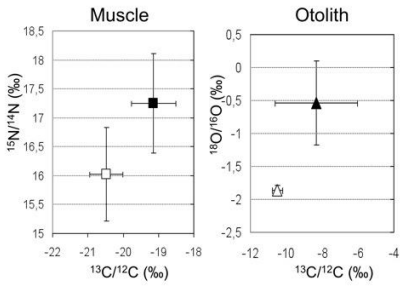


Fig. 1. Stable isotopic signatures in common soles entering (open symbols) and leaving (black symbols) Mauguio lagoon

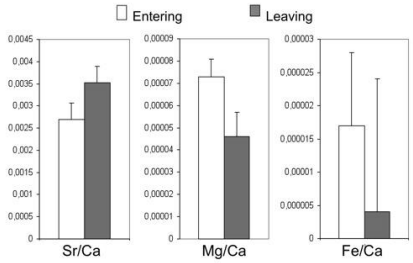


Fig. 2. Otolith chemical fingerprints in soles entering and leaving Mauguio

A likely explanation lies in the particular environmental conditions in lagoons (e.g., salinity, temperature, energy sources, contaminants). In particular, the high values in the ratio $^{15}N/^{14}N$ observed in leaving soles may be related to strong eutophication of the lagoon of Mauguio. In addition, comparison of muscle signatures with those of primary producers in the Mauguio system (own unpublished data, not shown) indicates that seagrasses (*Ruppia*,.*Potamogeton*), which were formerly common in Mauguio Lagoon but have declined precipitously [5], do not play a role as base of the common sole foodweb in the lagoon. Finally, the increase in otolith $^{18}O/^{16}O$ and Sr/Ca ratios suggests that salinity and temperature were higher in the lagoonal habitat than in the coastal habitat inhabited prior to migration. It is interesting to note that istotopic ratios in fish muscle change in a few months, which means that lagoonal signatures will disappear soon after moving back to the sea. In contrast, isotopic and chemical signals recorded in the otoliths would persist during the whole fish life, and are therefore best suited to analysing fish migrations between different environments.

References

1 - Salen-Picard C., Darnaude A.M., Arlhac D. and Harmelin-Vivien M., 2002. Fluctuations of macrobenthic populations: a link between climate-driven river run-off and sole fishery yields in the Gulf of Lions. *Oecologia*, 133: 380-388.

2 - Quignard J.P., Man Wai R. and Vianet R., 1984. Les poissons de l'étang de Mauguio (Hérault, France). Inventaire, structure du peuplement, croissance et polymorphisme des tailles. *Vie Milieu*, 34: 173-183.

3 - Dufour E. and Gerdeaux D., 2001. Apports des isotopes stables ($^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$, $^{36}S/^{34}S$, $^{87}SR/^{86}SR$) aux études écologiques sur les poissons. *Cybium*, 25: 369-382.

4 - Campana S.E., 1999. Chemistry and composition of fish otoliths: pathways, mechanisms and applications. *Mar. Ecol. Progr. Ser.*, 188: 263-297.

5 - Anonymous., 2008. Réseau de suivi lagunaire du Languedoc-Roussillon: Bilan des résultats 2007. Rapport RSL-08/2008, Ifremer, 363 p.

BLOOD CELL COUNT OF *MURAENA HELENA*, L.1758. FROM EASTERN ADRIATIC SEA NEAR DUBROVNIK, CROATIA

D. Dikic [1], D. Skaramuca [2]*, D. Lisicic [1], V. Benkovic [1], A. H. Kneževic [1], S. Matic-Skoko [3], P. Tutman [3], A. Gavrilovic [2] and B. Skaramuca [2]

[1] Department of Aquaculture, University of Dubrovnik, Cira Carica 4, 20000Dubrovnik, Croatia - daria.skaramuca@zg.t-com.hr
[2] Department of Animal Phisiology, Division Biology, Faculty of Science, University of Zagreb, Rooseveltov trg 6, 10000 Zagreb
[3] Institute of Oceanography and Fisheries, Šetalište I. Meštrovica 63, 21000 Split, Croatia

Abstract

Due to insufficient data on physiology, haemathology and immunology of *Muraena Helena*, L. 1758 a field study was conducted to measure the blood parameters of wild caught specimens from eastern Adriatic Sea, Elaphite islands, near Dubrovnik, Croatia.
Keywords: Adriatic Sea, Fishes, Physiology, Cell

Introduction

Blood cell analysis is an indicator of physiological condition and health status of fish engaged in aquaculture or ecotoxicological studies. Spotted moray eel, *Muraena helena* L.1758 is biologically and commercially interesting species. To our knowledge data on physiology, haemathology or immunology of this species are insufficient [1, 3]. In august 2009 a field study was conducted to establish the blood parameter values of wild caught Morays from eastern Adriatic Sea, Elaphite islands, near Dubrovnik, Croatia.

Materials and Methods

Morays (n=9) were caught with 300 m long line hooks on a depth of 20-30 meter. The hooks were set at 03:00 at night with squid chunks as bait, and collected two hours later. The average length was 72.37 ± 13.41 body weights were 1296.33 ± 804.45. All fish were collected alive and proceeded to blood collection immediately on spot. Each fish was sedated for 15 minutes with MS222 in a 100 L plastic barrel in oxygenated sea water (dose of MS222= 250 mg/L). After sedation blood was collected from the heart with a 10 ml syringe washed with anticoagulant heparin. Blood was immediately diluted 1:200 with Nett-Harricks dye. Cell parameters were evaluated in blood by standard non-automated haemathology assays using Bürker-Turk haemocytometer.

Results

Average red blood cell (RBC) count and platelet count was 3.513 ± 1.471 x 10^{11} / L. Average white blood cell (WBC) count was 9.33 ± 4.72 x 10^{10}/ L. Mean hematocrit values were 23.22 ± 8.13.

Tab. 1. Average biometric and selected hematology parameters of wild caught Spotted Moray eels

	Body lenght (cm)	Body weight (g)	RBC and platalet (x 10^{11} / L)	WBC (x 10^{10}/ L)	Hematocrite
Mean	72.37	1296.33	3.513	9.33	23.22
SD	13.41	804.45	1.471	4.72	8.13

Discussion

Shape, size and structure (Fig.1) of erythrocytes were similar as in majority of other fish species [2].

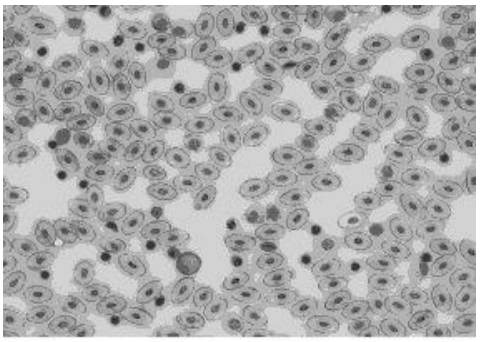


Fig. 1. Blood cells of Spotted Moray from eastern Adriatic Sea, Elaphite isalnds, near Dubrovnik, Croatia

Similarly, all leukocyte types typical found among variety of fish species were also recorded in Moray` s blood, as same as trombocytes of round, spindle and oval shapes [1].

References

1 - Wilhem Filho D, Eble GJ, Kassner G, Caprario FX, Dafré AL, Ohira M., 1992. Comparative hemathology in marine fish. *Comp Biochem Physiol Comp Physiol*.; Jun;102(2):311-21(scientific article).

2 - Glomski CA, Tamburlin J, Chainani M., 1992. The phylogenetic odyssey of the erythrocyte. III. Fish, the lower vertebrate experience. *Histol Histopathol*; Jul 7(3):501-28. Review (scientific article).

3 - Pellegrini M, Giardina B, Olianas A, Sanna MT, Deiana AM, Salvadori S, Di Prisco G, Tamburrini M, Corda M., 1995. Structure/function relationships in the hemoglobin components from moray (Muraena helena). *Eur J Biochem*. Dec 1;234(2):431-6 (scientific article).

MONOFILAMENT GILLNET SELECTIVITY FOR THE RED MULLET (*MULLUS BARBATUS*) IN THE EASTERN BLACK SEA COAST OF TURKEY, TRABZON

Ahmet Cemal Dinçer [1]* and Mustafa Bahar [2]
[1] Karadeniz Technical University, Faculty of Marine Sciences, Trabzon-Turkey - cdincer@ktu.edu.tr
[2] General Directorate of Coastal Safety, Province Directorate, Trabzon, Turkey.

Abstract
The mesh size selectivity of monofilament gillnets for red mullet (*Mullus barbatus*) was investigated using four different stretched mesh sizes (32, 36, 40 and 44 mm). Experimental fishing operations were carried out in Trabzon (Turkey) coasts of the Black Sea in springtime of 2002 and 2003. Fifteen trials were conducted giving a total catch of 303 red mullet. Selectivity on *M. barbatus* was assessed using the Holt's method. The optimum lengths (100% retention probability) were 13.16cm, 14.8cm, 16.44cm, and 18.09cm for the nets of 32, 36, 40 and 44 mm mesh respectively with a common selection factor of 4.11. Considering the minimum allowable landing size (13 cm) in force, 36 mm mesh is advised to be the best as it result more conservative approach in terms of size selectivity.
Keywords: Fisheries, Black Sea

Introduction
M. barbatus is an important fish species of the Black Sea and its catch has recently been recorded to diminish [1]. There are some evidences that overfishing and illegal fishing are mainly responsible for this decrease [2]. Gillnets are the main fishing gear to catch red mullet in Turkish Black Sea coasts. Gillnets are very size selective and therefore the mesh size may be considered to be the most important characteristic of a gillnet [3]. Gillnets are made of monofilament, multifilament or multifilament nylon. Despite the importance of this fishing gear little is known about its selectivity especially in the eastern coasts of the Black Sea in Turkey. Thus, this study aims to investigate the selectivity features of this gillnets to enable the necessary data for Turkish fisheries management.

Materials and Methods
The study was performed in May to June 2002 and in April to June 2003 in the Black Sea, Trabzon coasts with monofilament gillnets of 32 mm, 36, 40 and 44 mm mesh sizes. Fifteen valid hauls were obtained during the study period. The net configuration was in four sheets attached together, each having 50 m length and 2 m depth with a constant hanging ratio of 0.50. Experimental trials were carried out on boards of a commercial fishing boat of 9 m long and 28 hp, at depths ranging from 10 to 20 m. Sample sizes were measured to the nearest cm in terms of total length. The selectivity analysis was done by Holt's method [4], which is based on standard linear regression. The calculations were carried out in Excell package.

Results and Discussion
The total number of fish caught during the experimental fishing operations was 303, of which 26% from 32 mm, 35% from 36 mm, 18% from 40 mm and 21% from 44 mm mesh sizes. The mean lengths caught by each mesh sizes were 13.72 cm, 14.54 cm, 15.92 cm and 16.85 cm. Regression and selectivity calculations are shown in Table 1. The common selection factor (SF) is found to be 4.11 and corresponding optimum lengths (L_{opt}=SF x mesh size) are calculated as 13.16 cm, 14.80 cm, 16.44 cm and 18.09 cm for 32 mm, 36 mm, 40 mm and 44 mm meshes. The selectivity curves for the four mesh sizes are presented in Figure 1.

Tab. 1. Regression and selectivity paramaeters for the red mullet obtained by Holt's method for monofilament gillnets of four different mesh sizes

Smallest mesh size	32 mm	36 mm	40 mm	**Overall mean**
Largest mesh size	36 mm	40 mm	44 mm	
Intercept	-7.56	-12.97	-24.57	
Slope	0.540	0.796	1.493	
Selectivity factor	4.12	4.29	3.92	**4.11**
Variance	3.05	2.16	1.05	**2.09**
Standard deviation	1.75	1.47	1.02	**1.41**

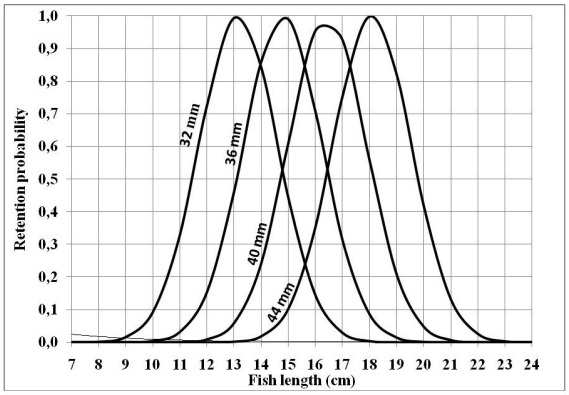


Fig. 1. Selectivity curves for the red mullet caught by monofilament gillnets of four different mesh sizes

The optimum lengths for *M. barbatus* for all meshes were over minimum landing size of 13 cm [5]. These values are also well over length at first maturity, which was reported in a previous study [6]. The ratio of undersized fish caught by each mesh were17.9%, 10.4%,1.8% and1.5% for 32 mm, 36 mm, 40 mm and 44 mm meshes, respectively. Among these four mesh sizes the 36 mm mesh had the highest catch efficiency (35%). The selectivity results show that the most recommended mesh size would be 36 mm, in behalf of being more conservative with regards to fishing management policies.

References
1 - FAO, 2004. FishStat Plus, Universal software for fishery statistical time series, http://www.fao.org/fi/website/ (April 20, 2007).
2 - Özbilgin H.; Tosunoglu Z.; Bilecenoglu M. and Tokaç A. 2004. Population parameters of *Mullus Barbatus* in Izmir Bay (Aegean Sea), using length frequency analysis. *J. Appl. Ichthyol*. 20: 231-233.
3 - Hovgard H. and Lassen H., 2000. Manual on estimation of selectivity for gillnet and longline gears in abundance surveys. FAO Fisheries Technical Report 397, FAO, Rome.
4 - Holt S. J., 1963. A method for determining gear selectivity and its application, ICNAF Special Publication, 5: 106-115.
5 - Anonymous., 2004. Fisheries regulation for marine and fresh waters for commercial fishery, 2004-2006 fishing period No.:36\1, Ministry of Agriculture and Rural Affair of Turkey, Protect and Control General Office, Ankara, 71 pp. (In Turkish).
6 - Genc Y., 2000. Dogu Karadeniz kiyilarindaki barbunya (*Mullus barbatus ponticus Ess*. 1927) baliginin biyoekolojik özellikleri ve populasyon parametreleri, Doktora tezi, Karadeniz Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Trabzon (In Turkish).

HEAVY METAL CONCENTRATIONS IN DIFFERENT TISSUES OF *MULLUS BARBATUS AND MULLUS SURMULETUS* FROM ISKENDERUN BAY, EASTERN COST OF MEDITERRANEAN, TURKEY

Meltem Dural [1]*, Esra Bickici [1] and Meltem Manasirli [2]
[1] Faculty of Fisheries Mustafa Kemal University 31200 Iskenderun, Hatay, Turkey - duralmeltem@yahoo.com
[2] Faculty of Fisheries University of Cukurova 01330 Balcali, Adana, Turkey

Abstract
Along the cost of Iskenderun Bay, there are agricultural lands and industrial plants (iron–steel plants, LPG, plants, oil transfer docks and cargo ship's ballasts water). Due to heavy industrial and agricultural activities in the region, the Bay is under stress of the many polutants. In this investigation, muscle was generally, accumulated the lowest levels of metals for two species. The results showed that metal accumulation in *Mullus surmuletus* was higher than *Mullus barbatus* tissues.
Keywords: Metals, Fishes, Monitoring

Introduction
The pollution of aquatic ecosystems by heavy metals is an important environmental problem as heavy metals constitute some of the most hazardous substances that can bioaccumulate [1] . Fish species are often the top consumers in aquatic ecosystems and thus metal concentrations in fish can act as an environmental indicator of the state of the environment [2]. Iskenderun Bay, in which there are large quantities of untreated industrial and domestic sewage, has one of the polluted coastal waters of Turkey and also has high economic importance for fishery. The aim of this work was to evaluate selected metal (Fe, Zn, Al, Cu, Pb, Mn, Ni, Cr, Cd) concentrations in different tissues of fish from two demersal species collected from Iskenderun Bay, which is situated on the eastern Mediterranean coast of Turkey.

Material and Methods
Red mullet (*Mullus barbatus*) and striped red mullet (*Mullus surmuletus*) samples were caught by fishermen's nets in 2009 from Iskenderun Bay. Total size and weight of fishes were for *M.barbatus* 36.05±2.45 g,14.08±0.27cm; for *M. surmuletus* 60.76±2,30g, 16.32±0.23 cm, respectively. The sample preparation and analysis were carried out according to the procedure described by UNEP reference methods [3]. The tissues digested with concentrated nitric acid and percholoric acid (2:1, v/v) at 60°C for 3 days. All samples assayed using ICP-AES. The accuracy of analytical procedure was checked by analyzing the Standard reference materials (National Research Council of Canada; dogfish muscle and liver) DORM2 in three replicates for each batch of fish samples digested. Recovery rates ranged from 93% to 100% for all investigated elements.

Result and Discussion
For skin; the highest Al (17.21 µg/g dw), Fe (20.28 µg/g dw), Cr (10.47 µg/g dw) concentration were detected in *M. barbatus*; the highest Pb (11.87 µg/g dw), Zn (5.58 µg/g dw), Ni (1.99 µg/g dw) concentration was detected in *M.surmuletus* from Iskenderun Bay . For muscle tissue; the highest Al (7.52 µg/g dw), Pb (8.10 µg/g dw), Fe (4.51 µg/g dw), Zn (0.77 µg/g dw), Ni (1.51 µg/g dw) concentration were detected in *M. surmuletus*; the highest Cr (6.56 µg/g dw), concentration was detected in *M.barbatus* from Iskenderun Bay. For liver tissue the highest Al (13.94 µg/g dw), Pb (15.18 µg/g dw), Fe (161.41 µg/g dw) was detected in *M.surmuletus* from Iskenderun Bay (Tab. 1, 2).

Tab. 1. The mean concentrations and Standard deviation of metals in the different tissues of *M.barbatus*

Metals	Heavy Metal Concentrations		
	Skin	Muscle	Liver
Al	17.21± 1.09[b]	6.67±0.17 [a]	13.35±0.33 [b]
Pb	5.85±0.64 [b]	2.26 ± 0.26 [a]	4.99±1.07 [ab]
Fe	20.28±1,56 [b]	3.31±0.28 [a]	102.8±4.01 [c]
Zn	1.04± 0.71	0.11±5.93	nd
Ni	0.12±0.27	nd	nd
Cd	nd	nd	nd
Cu	nd	nd	nd
Cr	10.47[a]±2.01	6.56[a]±1.03	6.76[a]±3.90
Mn	nd	nd	nd

Tab. 2. The mean concentrations and Standard deviation of metals in the different tissues of *M.surmuletus*

Metals	Heavy Metal Concentrations		
	Skin	Muscle	Liver
Al	9.39±0.39[b]	7.52± 0.15 [a]	13.94±1.56[c]
Pb	11.87±0.84 [ab]	8.10± 0.87 [a]	15.18±1.71[b]
Fe	12.67±0.66 [b]	4.51± 0.33 [a]	161.4±11.37[c]
Zn	5.58±0.75 [b]	0.77±0.17 [a]	5.22±0.94[b]
Ni	1.99±0.55 [a]	1.51± 0.18 [a]	2.55±0.73[a]
Cd	0.03± 0.01 [a]	0.14± 0.04 [a]	0.02± 0.01[a]
Cu	0.53±0.07 [a]	1.21±0.15 [b]	0.70±0.32[ab]
Cr	0.22±0.15	0.48± 0.17	nd
Mn	0.01±0.01	0.01±0.00	nd

Generally the levels of metals found in tissues of the *M. surmuletus* were generally higher than those found in *M. barbatus*. Our results show that generally metal accumulation is highest in liver and skin, while it is low in muscle in two species. This is probably due to their physiological roles in fish metobolism. It is well known that large amount of metallothionein induction occurs in the liver tissue of fishes, therefore the liver tissue is highly active in the uptake and storage of heavy metals [4, 5, 6, 7]. Turkish legislation establishes maximum levels for four of the metals studied, above which human consumption is not permitted as; 0.1 mg/kg for Cd, 1.0 mg/kg for Pb, 20.0 mg/kg for Cu, 50 mg/kg for Zn [19]. Food and Agricultural Organization limits for Cd and Pb 0.5 mg/kg, for Cu and Zn 30 mg/kg [20].
In conclution, the concentrations of these metals measured in the muscle of the three species studied were generally lower than the levels issued by FAO and Turkish legistation. Yet, Pb concentrations in the muscle tissues were higher than the maximum levels set by law.

References
1 - Tarifeno-Silva E., Kawasaki L., Yn D.P., Gorden M.S. and Chapman D.J.,1982. Aquacultural Approaches to Recycling Dissolved Nutrients in Secondarily Treated Domestic Waste Waters: Uptake of Dissolved Heavy Metals by Artificial Food Chains. *Water Research*., 16:59-65.
2 - Widianarko B., Van Gestel C.A.M., Verweij R.A. and Van Straalen, N.M.,2000. Associations Between Trace Metals in Sediment, Water and Guppy, Poecilia reticulata (Peters), from Urban Streams of Semarang, Indonesia. *Ecotoxicology and Environmental Safety*., 46:101-107.
3 - UNEP/FAO/IOC/IAEA.,1984.Determination of total cadmium, zinc, lead and copper in selected marine organisms by Flameless Atomic Absorption Spectrophotometry. Reference Methods for Marine Pollution Studies., No. 11,Rev 2.
4 - Heath A.G., 1987. Water Pollution and Fish Physiology. CRC press, Florida, 245pp.
5 - Langston W.J., 1990. Toxic Effects of Metals and Incidence of Marine Ecosystem. In:Furness RW, Rainbow PS, editors. Heavy Metals in the Marine Environment. CRC Press, New York 256pp.
6 - Marafante E., 1976. Binding of mercury and zinc to cadmium binding protein in liver and kidney of gold fish. *Experienta.*, 32: 149-150.
7 - Hodson P.V., 1988. The effect of metal metabolism on uptake disposition and toxicity in fish. *Aquat. Toxicol*., 11:3-18.

ECOLOGIC AND TAPHONOMIC TRENDS IN MOLLUSCAN DEATH ASSEMBLAGES OF HUMAN-IMPACTED AREAS: ISRAELI EASTERN MEDITERRANEAN

Yael Edelman-Furstenberg [1]*
[1] Geological Survey of Israel - yael@gsi.gov.il

Abstract
Man-induced changes in the Israeli Mediterranean shore had a strong ecological imprint on the biota. Molluscan death-assemblage results from near a sewage outlet show that species richness and number of specimens/gram sediment are considerably lower than those from peripheral stations. Unexpectedly, there is a considerable difference in species richness and total abundance/gram sediment between summer and winter in death assemblages from the treated sewage outlet station. This may point to extremely high sedimentation rates for this station and/or extremely strong impact of the sewage on the fauna.
Keywords: Sediments, Sewage Pollution, Mollusca, Eastern Mediterranean

Introduction
During the past decades man-induced nutrients were introduced to the eastern Mediterranean. These man-induced changes in the Israeli Mediterranean shore had a strong ecological imprint on the biota.This is especially true for the area of Palmahim, in the vicinity of the treated sewage sludge outlet. Recent foraminifera and polychaete studies [1] show great variations along the eastern Mediterranean shore tracking eutrophication trajectories. Macrobenthic invertebrates such as shelled molluscs are known to be sensitive indicators of seafloor oxygen levels, water energy and sediment mass properties. After death, skeletal macrobenthic material is buried and preserved in the sediment record. Investigating the death assemblage record of these organisms should capture the composition and community structure of the living community better than a short-term or single biological census due to the summing of seasonal and annual variations. In this way, ecological characterizations based on macrobenthic death assemblages can be considered as a more complete "modern" picture than information based on live censuses alone.

Material and Methods
A sub-sampling of box core sediment samples were examined from an along-shore transect that crosses the treated sewage sludge area but also includes areas peripheral to the main impact area, parallel to Hyams [2] study area. Molluscan death assemblages from summer (07.03) and winter (01.04) from three stations were analyzed and species richness, evenness, relative and total abundance were calculated. Also, taphonomic characteristics (shell state preservation) of the dominant bivalve shells from the different stations were scored.

Results ans Discussion
Thirty five gastropod species were identified and 45 bivalves. Assuming that the molluscan death assemblages average out the seasonal and annual variations, each sampling site should have yielded similar data for samples taken during summer and winter. Yet, molluscan results from the area of the sewage outlet (station PL3-summer) show that species richness and number of specimens per gram sediment are considerably lower than those from the same location during winter as well as from the peripheral stations PL29 and AS1. Twenty two species (Margalef's richness index of 8.9) and 0.4 mollusc abundance/gram sediment were recorded for the summer station at PL-3 as opposed to 39 species (Margalef's index of 13.1) and 4.3 molluscs abundance/gram sediment recorded for the winter sampling of the same station. The expectation was that the sewage sludge, which enters the water year-round, would affect the faunal assemblage of both sampling periods in the same way, by suppressing the fauna. However, the removal of the sludge during the winter (strong water currents, biological churning of the sediment, [1]) inhibits a long-term effect on the faunal composition and assemblage community structure, which is only seen as a local and direct result during the summer sampling, when the sludge covering accumulates.
This unexpected difference in species richness and total abundance between summer and winter in death assemblages from the treated sewage outlet station (PL3) is similar to that seen in the live benthic foraminifera data (Fig. 1). The number of foraminifera specimens per cc in station PL3 was low during summer sampling and high during winter sampling [1]. In the figure both the foraminifera and molluscan measurements are shown against the sludge accumulation thickness, which is thick during the summer, ~10 cm, and non-existent during the winter. This may point to extremely high sedimentation rates for this station on the one hand and extremely strong impact of the sewage on the fauna on the other hand. It seems that under extremely stressful environmental conditions, such as anthropogenic impacts on marine environments, the time-averaged death assemblage is skewed, and acts more like a "snapshot" assemblage [3]. Thus, even a time-averaged death assemblage carries effects of the anthropogenic impact on the community structure of the molluscs.

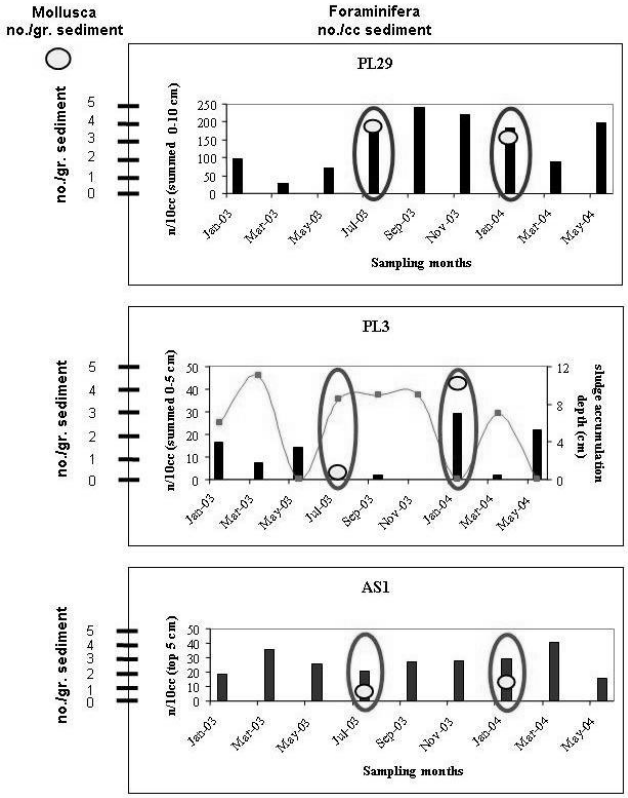


Fig. 1. Molluscan differences between summer and winter in the sewage area (this study) are similar to those seen in the live benthic foraminifera [2]. Bar graphs: total standing stock of living (stained) individuals/10 cc from PL29, summed over the top 0-10 cm of the sediment; PL3, summed over the 0-5 cm; and AS1, summed over the top 0-5 cm. Sludge accumulation thickness is shown for PL3. Circles: total molluscan abundance

References
1 - Hyams-Kaphzan, O., et al., 2009. Natural oligotrophy vs. pollution-induced eutrophy on the SE Mediterranean shallow shelf (Israel): Environmental parameters and benthic foraminifera. *Mar. Pollut. Bull.*, doi:10.1016/ j.marpolbul.2009.07.010.
2 - Hyams, O., 2006. Eutrophication affecting benthic foraminifera on the oligotrophic eastern Mediterranean shallow shelf. Ph.D. thesis, Ben-Gurion University of the Negev, 157 pp.
3 - Kidwell, S.M. and Bosence, D.W.J., 1991. Taphonomy and time-averaging of marine shelly faunas. *In:* Allison, P.A., Briggs D.E.G. (eds.), Taphonomy, Releasing the Data Locked in the Fossil Record. Plenum Press, New York, pp. 115-209.

ON BOARD TRAWL SAMPLING IN THE THERMAIKOS GULF. SEASONAL QUANTITATIVE AND QUALITATIVE COMPOSITION OF THE CATCH

Kostantinos Efthimiadis [1], Erotokritos Chairistanidis [1], Pavlos Vidoris [1] and Argyris Kallianiotis [1]*
[1] NAGREF – Fisheries Research Institute - akallian@inale.gr

Abstract
The purpose of this work is to describe the qualitative and quantitative composition of the catch in Thermaikos Gulf, using a special bottom trawl. It is also tested if there is a statistically important differentiation in the abundance between the inner gulf, where the fishing with trawlers is not allowed and the outer gulf, where the fishing with trawlers is allowed.
Keywords: Aegean Sea, Trawl Surveys, Fisheries

Introduction
Thermaikos Gulf is the biggest gulf of the Aegean Sea. The Rivers Axios, Aliakmonas, Loudias and Galikos, and several smaller, are flowing into Thermaikos, contributing to its strong productivity. The existence of 23 ports on the shores of the four counties that surround Thermaikos, with a total of 1453 vessels (30 purse seiners, 68 trawlers, 12 boat seiners and 1343 coastal) of coastal and open sea fisheries, reveals the intensive fishing activity within the limits of the bay.

Materials and Methods
The experimental sampling was conducted with professional trawler. Twenty hauls took place, each lasting 30 minutes in each sampling period, in default stations, on May, on July, on September and on December of 2008. The depth of the stations ranged between 16 and 90 meters. . The abundance index was calculated for each season. By using ANOSIM, the statistical differentiation of two different areas of Thermaikos was estimated, according to the access or not of trawlers in these areas. Specifically, the access of trawlers is not allowed to the inner part of the gulf. The remaining part of the gulf where the access of trawlers is allowed, is referred as outer Thermaikos. The SIMPER analysis revealed which species mainly contributed to the differentiation between the two areas of Thermaikos. All the above mentioned analyses were conducted using the PRIMER software [1].

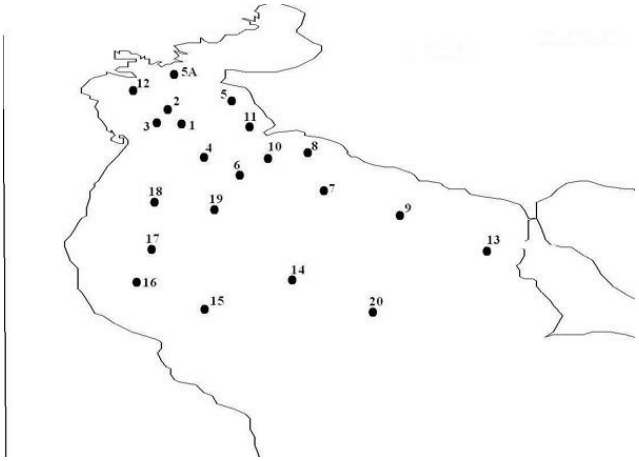


Fig. 1. Map of stations sampled.

Results and Discussion
In all four samplings 122 species were recorded, of which 94 (77%) were fishes, 12 (10%) were cephalopods and 16 (13%) were crustaceans. Specifically, on May, 88 species were recorded, of which 65 (74%) were fishes, 8 (9%) were cephalopods and 15 (17%) were crustaceans. On July, 94 species were recorded, of which 71 (76%) were fishes, 10 (11%) were cephalopods and 13 (13%) were crustaceans. On September, 91 species were recorded, of which 70 (77%) were fishes, 10 (11%) were cephalopods and 11 (12%) were crustaceans. Finally, on December, 87 species were recorded, of which 68 (78%) were fishes, 9 (10%) were cephalopods and 10 (12%) were crustaceans. The species that occurred in all four sampling seasons were 64 (52%), while the species that occurred only in one sampling season were 25 (20%). The most abundant species in all four sampling seasons are the following: 1) *Liocarcinus depurator* (12007,9 individuals/km^2), 2) *Serranus hepatus* (8836,0 individuals/km^2), 3) *Trachurus mediterraneus* (5949,1 individuals/km^2), 4) *Mullus barbatus* (5226,7 individuals/km^2), 5) *Arnoglossus laterna* (4689,0 individuals/km^2), 6) *Pagellus acarne* (4345,8 individuals/km^2), 7) *Diplodus annularis* (3056,2 individuals/km^2). ANOSIM was used in order to test if there is a statistically important differentiation in the abundance between the inner gulf and the outer gulf. The resulting value R=0,659, shows that the stations of inner Thermaikos are statistically different from the stations of the outer Thermaikos on May. This is also the case for the other sampling months, where the values of R are R=0,636, R=0,658 and R=0,53, for July, September and December, respectively. The SIMPER analysis showed that the species which mainly contribute to the statistically important differences are the following: *A. laterna*, *L. vulgaris*, *G. niger*, *L. depurator*, *T. minutus*, *D. annularis*και *P. longirostris*. This result is attributed to the fact that in inner Thermaikos the trawlers are not allowed and the concentration of nutrients is higher due to the outfall in Thermaikos of the rivers. However, there is only little knowledge of the effects of fisheries with trawlers on marine organisms in the Mediterranean [2].

References
1 - Carr M.K., 1997. PRIMER User Manual. Plymouth Marine Laboratory. 36 p.
2 - Moranta J., Massuti E., and Morales-Nin B., 2000. Fish catch composition of the deep-sea decapod crustacean fisheries in the Balearic Islands (western Mediterranean). *Fisheries Research*, 45: 253-264.

FROM THE TETHYS OCEAN TO THE MEDITERRANEAN SEA, HOW TECTONICS SHAPED *ECHINOCARDIUM CORDATUM* EVOLUTION.

Emilie Egea [1]*, Gwilherm Penant [1], Jean-pierre Féral [1] and Anne Chenuil [1]
[1] UMR6540-DIMAR - egea@univmed.fr

Abstract

Irregular echinoids constitute one of the most important groups of the Mediterranean benthic fauna. The genus *Echinocardium* is well represented but its diversity seems to have been underestimated. Genetic analyses of *E. cordatum* highlighted a complex of at least five cryptic specieswhich appearance seems to have been greatly driven by the paleontological history of the Mediterranean Sea.
Keywords: Biodiversity, Biogeography, Echinodermata, Ocean History

Introduction

Echinocardium [Loveniidae, Spatangoida] is a widespread genus of irregular sea urchins, presently composed of six nominal species. Three of them can be observed in sympatry in the Mediterranean Sea: *E. cordatum* (Pennant, 1777), *E. mediterraneum* (Forbes, 1844) and *E. capense* (Mortensen, 1907). Genetic studies [1] revealed that *E. cordatum* is a complex of at least five different cryptic species encountered in the Atlantic (A, B1), Pacific (NP, SP) and Mediterranean (B1, B2) basins (Fig 1). Its antitropical distribution raises the question of the formation of these cryptic species complex with respect to paleogeography.

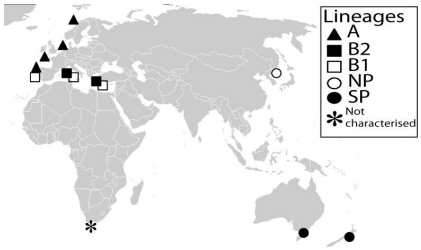


Fig. 1. Distribution of the cryptic species in *E. cordatum*

Material and Methods

A 430 bp portion of the 16S ribosomal gene and a 560 portion of the cytochrome oxidase subunit I (CO1) of the mitochondrial genome were amplified for several Spatangoida species (Species in bold Fig1). Sequences of 16S and CO1 for 12 additional Spatangoid species and one Echinolampadidae were retrieved from genebank (Fig 1). The phylogenetic tree was constructed using Bayesian inferences as performed in MrBAYES software [2], under the GTR+I+G evolutionary model as determined by MODELTEST [3] Topology within *E. cordatum* was confirmed by the intronic region of the Elongation Factor α (EF1) of the nuclear genome. Molecular estimates of divergence times were calculated using the Bayesian method of Thorne et al. (1998) [4] as implemented in the Multidivtime package of PAML [5]. Paleontological data from the litterature were used to calibrate the topology. Hence, the divergence of *E. cordatum* and the other species of the genus of the tree are estimated to be 12 to 40 MYR old [6], and the appearance of the Schizasteridae family, 95MYR old [7]. *Conolampas sigsbei* (Cassiduloida, Echinolampadidae) was used as outgroup for the study establishing the root age at about 200MYR [7].

Results

Bayesian inferences allowed generating a satisfying phylogeny of the studied species, and in particular, of *E. cordatum* nominal species as well as aging its cryptic lineages. The split between cryptic specie A and the remaining lineages is estimated to have occurred some 13MYR ago, and the split between B1 and B2 is dated to 5 MYR.

Discussion

These data are consistent with geological information about the evolution of the Tethys Ocean and Mediterranean Sea under the following scenario. Geographic isolation in the two basins resulting from the closure of the Tethys around 10 MYR ago leaded to allopatric differentiation of the species A in the Atlantic-Mediterranean basin and the common ancestor of lineages P (NP & SP) and B (B1 & B2) in the Pacific basin. Between 13 and 5 MYR ago, this common ancestor evolved to create two modern species in the Pacific Ocean, NP and SP and migrated back to the Mediterranean Sea [via South Africa (where the nominal species *E. cordatum* is found)] to diverge in two others species, B1 and B2, around 5 MYR ago. Despite the fact that these species are now found in sympatry, they might have been formed by allopatric speciation, as their divergence time concords with the Messinian crisis (6MYR ago) during which the Mediterranean Sea experimented extensive desiccation and sea level changes[8]. The salinity increase that results from the Messinian crisis might have caused the extinction of lineage A into the modern Mediterranean Sea. This hypothesis could be tested via salinity tolerance experiments on lineages A and B.

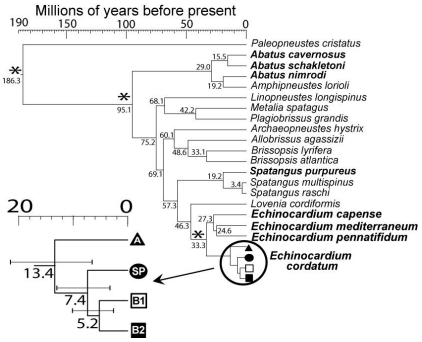


Fig. 2. ML tree obtain from 16S and CO1 concatenated genes using Bayesian inferences with datation of nodes and 95% confidence interval for *Echinocardium cordatum* . * Nodes with fossil records. Cryptic species NP not shown

Long thought to be a single cosmopolitan species, *E. cordatum* revealed to be a complex of cryptic species which evolution has been extensively intertwined with the evolution and history of the Mediterranean Sea.

References

1 - Chenuil, A. and J.-P. Féral., 2001. Sequences of mitochondrial DNA suggest that *Echinocardium cordatum* is a complex of several sympatric or hybridizing species. A pilot study., in Echinoderm Research Proc. 6th Eur. Conf. Echinoderm, Banyuls-sur-mer, France,p. 15-21.

2 - Ronquist, F. and J.P. Huelsenbeck., 2003. MrBayes 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics*, 19(12): p. 1572-1574.

3 - Posada, D. and K.A. Crandall., 1998. MODELTEST: testing the model of DNA substitution. *Bioinformatics*, 14(9): p. 817-818.

4 - Thorne, J.L., H. Kishino, and I.S. Painter., 1998. Estimating the rate of evolution of the rate of molecular evolution. *Mol Biol Evol*, 15(12): p. 1647-57.

5 - Yang, Z., 2007. PAML 4. Phylogenetic Analysis by Maximum Likelihood. *Mol Biol Evol*, 24(8): p. 1586-1591.

6 - Philippe, M., 1998. Les échinides miocènes du bassin du Rhône: révision systématique. Nouvelles archives du Muséum d'Histoire Naturelle de Lyon. Vol. Fascicule 36. 441.

7 - Smith, A.B., et al., 2006. Testing the Molecular Clock: Molecular and Paleontological Estimates of Divergence Times in the Echinoidea (Echinodermata). *Mol Biol Evol*, 23(10): p. 1832-1851.

8 - Néraudeau, D., et al., 2001. Changing biodiversity of Mediterranean irregular echinoids from the Messinian to the Present-Day. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 175(1-4): p. 43-60.

REPARTITION DES CRUSTACES DECAPODES DANS LE GOLFE DE GABES

Henda El lakhrach [1]* and Abdallah Hattour [2]
[1] Institut National des sciences et technologies de la mer. BP .1035- 3018 Sfax. - hendalak@yahoo.fr
[2] Institut National des Sciences et Technologies de la Mer- Salammbô

Abstract
La répartition des crustacés semble occuper l'ensemble du golfe de Gabés (côtes sud-est de la Tunisie). La présente étude a ciblé les crustacés décapodes du golfe de Gabès. Elle a permis d'inventorier 35 espèces et permis aussi de comparer la richesse spécifique de ces crustacés dans les différentes aires de distribution. Le traitement statistique des données a permis de dresser la répartition spatiale de ces derniers.
Keywords: Gulf Of Gabes, Crustacea

Introduction
Le golfe de Gabès, large échancrure situé sur le littoral sud de la Tunisie, constitue le golfe le plus important du littoral tunisien ([1], [3]). L'étude de la répartition des crustacés sur les fonds du golfe de Gabès s'inscrit dans le cadre d'une étude bionomique du plateau continental. Ce dernier a fait l'objet de très peu de travaux de recherches.

Matériel et méthodes
Durant le printemps 2009, une campagne de pêche expérimentale a été effectuée à bord du navire océanographique et de recherche le « N/o Hannibal » au niveau de la région du golfe de Gabès. Quarante stations ont été échantillonnées, couvrant une grande partie du golfe. Les traits sont répartis entre 20 et 260 m de profondeur. Deux types d'engin ont été utilisé :
- un chalut de fond du type « crevettier » pour les faibles profondeurs (< à 50 m)
- un chalut à grande ouverture verticale (GOV) pour les grandes profondeurs (de 60 à 260 m).
Pour étudier la répartition des crustacés décapodes, nous avons calculé la richesse spécifique de chaque station, qui est définie par le nombre d'espèces recensées à une échelle d'espace bien déterminée. La cartographie des crustacés décapodes a été réalisée à l'aide d'un système d'informations géographiques (SIG). Le SIG permet de croiser les données cartographiques avec d'autres données spécialisées par le biais de requêtes et d'outils de traitements [2].

Résultats et discussion
La détermination des espèces prises par chalutage nous a permis d'identifier 35 espèces de crustacés décapodes (Tab 1) dont les plus importantes sont : *Penaeus keratherus, Metapenaeus monoceros, Medorippe lanata, Inachus sp et Pagurites ermita*. Ces espèces sont inégalement reparties sur toute l'aire investiguée par les chaluts. Les espèces appartenant à la famille des Penaeidae sont dominantes. La courbe de la richesse spécifique en fonction de la position montre une répartition irrégulière des crustacés décapodes. Les stations G8, G10 et G14 se caractérise par une richesse élevée (12 ou 13 espèces). Par contre, les stations G9, G38 et G39 présentant une richesse nulle (Fig. 1). La différence de la richesse spécifique pourrait être due aux conditions environnementales ; paramètres physico-chimiques (température, PH, salinité) et également à la nature du fond (vaseux, sableux, sablo-vaseux, vaso-sableux).

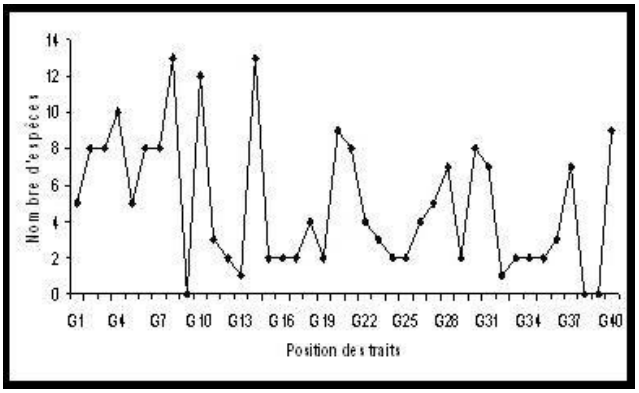


Fig. 1. Variation de la richesse spécifique en fonction de la position (G)

Tab. 1. Liste d'espèces des Crustacés Décapodes rencontrés dans le golfe de Gabès

Order Decapoda			
Sous-ordre Natantia	Sous-ordre Reptantia Brachyura	Sous-ordre Reptantia Anomura	Sous-ordre Reptantia Macura
Famille Crangonidae	Famille Dorippidae	Famille Diogenidae	Famille Nephropidae
Pontocaris cataphracta (Olive, 1792)	*Ethusa mascarone* (Herbst, 1788)	*Pagurixtes ermita* (Linnaeus, 1767)	*Nephrops norvegicus* (Linnaeus, 1758)
Famille Palaemonidae	*Medorippe lanata* (Linnaeus, 1767)	*Dardanus arrosor* (Herbst, 1796)	
Palaemon elegans (Rathke, 1837)	Famille Dromiidae	*Pagurixtes oculatus* (Fabricius, 1775)	
Famille Sycionidae	*Dromia personata* (Linnaeus, 1759)	Famille Paguridae	
Sycionia carinata (Brünnich, 1768)	Famille Euryplacidae	*Paguris bernardus (Linnaeus, 1758)*	
Famille Penaeidae	*Eurycte crenata* (Haan, 1835)		
Penaeus kerathurus (Forskal, 1755)	Famille Goneplacidae		
Metapenaeus monoceros (Fabricius, 1798)	*Goneplax rhomboides* (Linnaeus, 1758)		
Parapenaeus longirostrus (Lucas, 1846)	Famille Majidae		
Metapenaeus palaestinensis (Steinitz, 1932)	*Inachus dorsettensis* (Pennant, 1777)		
Famille Processidae	*Macropodia longirostris* (Fabricius, 1775)		
Processa canaliculata (Lesch, 1915)	*Maja crispata* (Risso, 1827)		
Processa edulis (Risso, 1816)	*Maja squinado* (Herbst, 1788)		
Famille Alpheidae	*Pisa armata* (Latreille, 1803)		
Alpheus inopinatus (Holthuis et Gottlieb, 1958)	Famille Parthenopidae		
Synalpheus gambarelloides (Nardo, 1847)	*Parthenops massena* (Herbst, 1790)		
	Famille Xanthidae		
	Pilumnus hirtellus (Linnaeus, 1761)		
	Famille Leucosiidae		
	Ilia nucleus (Linnaeus, 1758)		
	Famille Calappidae		
	Calappa granulata (Linnaeus, 1758)		
	Famille Latreillidae		
	Latreillia elegans (Roux, 1830)		
	Famille Portunidae		
	Liocarcinus depurator (Linné, 1758)		
	Liocarcinus marmoreus (Leach, 1816)		
	Carcinus aestuarii (Nardo, 1847)		
	Macropipus tuberculatus (Roux, 1830)		

References
1 - Azouz A., 1971. Etude des biocénoses benthiques et de la faune icthyologique des fonds chalutables de la Tunisie, région nord et sud-est. Thèse Sci. Nat. Univ. Caen, 1971. AO 6471 : 234 pp.
2 - Bouaziz S., 2002. Elaboration d'un Système d'Information Géographique (S.I.G) pour l'étude et la cartographie géologique de la région d'Agareb. Mémoire de DEA, 87 p. Fac. Sci. Sfax.
3 - Burollet P.F., Clairefond P. et Winnock E., 1979. La mer Pélagienne. Etude sédimentologique et écologique du plateau tunisien et du golfe de Gabès. Ann. Univ. Provence, 6 (1;1-345).

INTRODUCED SPECIES AND THEIR IMPACTS IN THE BLACK SEA

Naciye Erdogan [1], Ertug Duzgunes [2]*, Hamdi Ogut [2] and Nazli Kasapoglu [2]
[1] ODÜ University Faculty of Marine Sciences
[2] KTU Faculty of Marine Science(2) - ertug@ktu.edu.tr

Abstract

In the last half of the 20th century, many forms of marine organisms, belonging to various levels of food chain, native to Indian Ocean and the Mediterranean Sea have been unintentionally introduced into the Black Sea mainly by the means of shipping vessels or water exchange through Sea of Marmara. Along with the changes in the climate due to the global warming, a process namely "Mediterreneanisation" has been taken place in the Black Sea, leading to collapse of fisheries i.e impact of Comb jellyfish on anchovy stocks, and Rapa whelk *Rapana venosa* on mussel banks.

Keywords: Black Sea, Bivalves, Gastropods

Introduction

Hundreds of species from various flora and fauna have been introduced to the Turkish seas since the beginning of 20th century. For instance, more than 85 species of macrophytes including "killer algae" introduced to the Mediterranean, nine of them are considered as invasive, i.e., playing a conspicuous role in the recipient ecosystems. The Black Sea biodiversity has become extremely more sensitive to immigrants' expansion than those in other seas. Rich diversity of biotopes and the poor local species diversity provide favorable conditions for some exotic invaders finding naïve ecological niches with no competitors or predators (Gomoiu, 2001). Unfortunately, the data generated from controlled experiments are very limited; therefore, observations will be presented here.

Invasive Species The number of invasive species penetrations into the Black Sea peaked during 2000s (Fig. 1) (Gomoiu 2001). The main invaders establishing and having the most dramatic impacts on species diversity are Rapa whelk *Rapana venosa*, *Scapharca cornea*, Comb jelly fish *Mnemiopsis leidyi*, Pacific Mullet *Mugil soiuy*. *Rapana venosa*, introduced during 1940s, spread all over the Black Sea due to lack of predators ie sea stars (Duzgunes and Feyzioglu, 1994; Saglam et al, 2009).

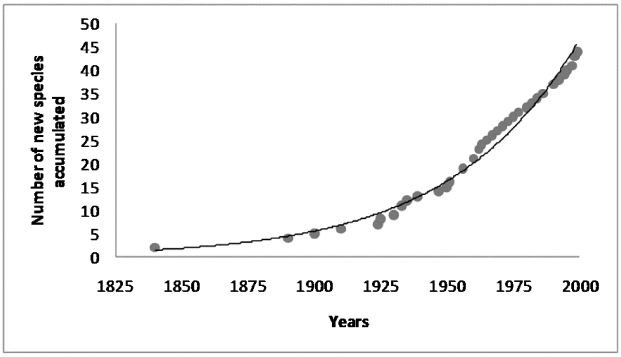


Fig. 1. Number of new species accumulated for years (redrawn, Gomoiu, 2001)

It has devastatedmajority of mussel banks *Mytilus galloprovincialis* and baby clam *Chamelina gallina* stocks (Table 1). At present, mussels only survived at habitats having steep slopes and high currents. Mussels are essential organisms to slow down or prevent eutrification by filter feeding in the Black Sea. Another introduced species *Scapharca cornea*, a filter feeder bivalve, become established and spread due to the fact that they are less exposed to predation owing to thicker shell (Duzgunes, 1995). Comb jelly fish *Mnemiopsis leidyi*, feeding on eggs and larvae of small pelagics e.g. anchovy, caused to collapse of fisheries in the Black Sea during the late 1980s. Total anchovy catch in the Black Sea dropped sharply from 526000 metric tonnes to 85000 from 1988 to 1991 (Dumont et all, 2002).

Tab. 1. Impact of major introduced species in the Black Sea

Species	İmpact	Remarks
Rapana venosa	Destroyed mussel and baby clam stocks	No predator in the Black Sea and due to its resistant egg cysts reproduction rate is too high
Anadara cornea	Replaced *Mytilus galloprovincialis*	Have no economical value and under predation of *Rapana venosa* at present
Mnemiopsis leidyi	Predating on fish eggs and larvae of small pelagics	Decreased overall biodiversity in the Black Sea
Mugil soiuy	Food competition with native mullet species	Majority of the native mullet species are now out of fisheries

Pacific mullet, introduced into Azov Sea in 1985, was first observed in the Black Sea in 1989 (Ünsal,1992; Okumus and Bascinar, 1997). It successfully competes with such native mullet species as *Mugil cephalus*, *M. auratus* for food. As a result of this competition, catch quantity of native mullet species declined from 14189 tones to 1518 tones during the period 2000-2008. At present commercial catch shifted from native to the pacific mullet. Establishment of both *Rapana venosa* and *Mugil soiuy* was so efficient, as a result the species were able to increase their numbers significantly allowing an economically feasible fishery towards their harvest.

Conclusions

Species abundance and diversities changed significantly as a result of introduced species.

References

1 - Gomoiu, M. T., 2001. Impacts of naval transport development on marine ecosystems and invasive species. *Journal of Environmental Protection and Ecology*, 2:475-481.

2 - Okumus, I., Bascinar, N., 1997. Population structure, growth and reproduction of introduced Pacific mullet, *Mugil so-iuy*, *in the Black Sea. Fisheries Research. 33 (1-3):131-137 p.*

3 - Saglam, H., Duzgunes, E., and Ogut, H., 2009. Reproductive ecology of the invasive whelk *Rapana venosa* Valenciennes, 1846, in the southeastern Black Sea (Gastropoda: Muricidae). *ICES Journal of Marine Science*, 66: 1865-1867.

4 - Duzgunes, E., Feyzioglu, A. M., 1994. Population parameters and growth of *Rapana thomasiana* Gross, 1861 off Trabzon coasts. 1st National Ecology and Environ.

5 - Unsal, S.,1992. A new mullet species for Turkish seas: *Mugil soiuy*, Basilewsky. Doga-Tr. *J. Vet. Animal Sci*. 16: 427–432 p.

THE PRESENCE OF INDO-PACIFIC PUFFER FISH *TORQUIGENER FILAVIMACULOSUS* HARDDY & RANDALL,1983 IN THE ISKENDERUN BAY, THE EASTERN MEDITERRANEAN COAST OF TURKEY

Deniz Erguden [1]* and Mevlut Gurlek [1]
[1] Mustafa Kemal University Faculty of Fisheries - derguden@gmail.com

Abstract
The first record of the lessepsian pufferfish (*Torquigener filavimaculosus* Hardy & Randall, 1983) in coast of Iskenderun Bay, Eastern Mediterranean Sea, is given in the present paper . A single young specimen was sampled with the research trawler "Mustafa Kemal I" in June, 2008, and morphological characteristic and fin formulas are described with detail.
Keywords: Fishes, Species Introduction, Teleostei, Eastern Mediterranean

Introduction
The family Tetraodontidae is represented in the Mediterranean Sea by four genera and nine species [1,2]. *Torquigener filavimaculosus*is distributed in shallow waters and found on sand-muddy bottoms at depths of 3 to 57 m. It is carnivorous feeding on small benthic invertebrates. *T. filavimaculosus* has a distribution throughout Indian Ocean Red Sea, Persian Gulf and eastern Africa to Seychelles [1,3]. The puffer fish *T. filavimaculosus* was recorded for the first time in the Mediterranean Sea from Haifa Bay, Israel [4]. Following, Bilecenoglu [5,6] based on two specimens observed from the south western Mediterranean coast of Turkey (off Fethiye shore), expanded the westward distribution range of the species. Lately this species is recorded by Corsini-Foka [7] from Rhodes island.

Material and Methods
On 26 June 2008 a 52.0 mm total length (*Lt*), 48.2 mm fork length (*LF*) and 42.6 mm standart length (*Ls*), specimens of puffer fish *T. filavimaculosus* Harddy & Randall, 1983 was caught by the research trawler "Mustafa Kemal I" from Iskenderun Bay (36^0 33' N- 36^0 03' E) at a depth of 24 m (Fig. 1). The single specimen has been deposited at the ichthyological collection Museum of Faculty of Fisheries, Mustafa Kemal University. Some morphometric and meristic characteristics of the specimen are given in Table 1.

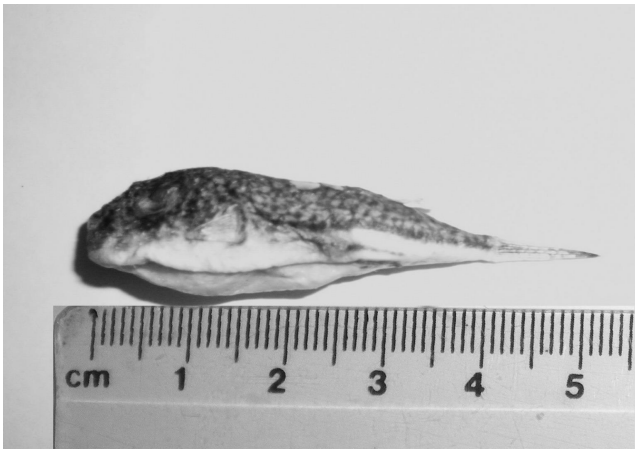


Fig. 1. *Torquigener filavimaculosus* caught off Iskenderun Bay, Eastern Mediterranean Sea, Turkey (52.0 mm L_t)

Results and Discussion
Body elongate, somewhat compressed laterally and inflatable. The chin distinct, mouth small and terminal with conspicuous lips, covered with short papilllae. Eyes elongated. Origin of dorsal fin slightly in front of anal fin origin. Dorsal and anal fins were elongated and pointed. Caudal fin truncated. Pectoral fin rounded with wide base. Pelvic fins absent. The skin had numerous londitudinal pleats. *Colour:* The body is lightbrownish with regularly distributed grey dots dorsally and white ventrally. A mid lateral line with longitudinal series of yellow to olive-green spots. Caudal fin with brown spots, dorsal fin spotted, anal and pectorals fin transparent. Measurements, counts and body coloration of puffer fish *T. filavimaculosus* agree with descriptions of Hardy & Randall [8], Golani [4] and Golani et al [1]. *T. filavimaculosus*, is very similar to *Torquigener brevipinnis* (Regan, 1902) previously described from the Red Sea and adjacent waters by Hardy & Randall [8]. *T. filavimaculosus* further differ from *T.brevipinnis* inhaving caudal fin markings less regular andmore numerous on each ray andthe dorsal fin arises above the vent. Both species differ from *Torquigener hypselogeneion* in the relative eye diameter, caudal pedunclelength (smaller dimensions in *T. hypselogeneion)*, and in having more dense ventral spination [9]. The present record is caught the first of the species from the coast of Iskenderun Bay, Eastern Mediterranean Sea. While a single specimen does not necessarily indicate an established population. This species may be capable of colonization in the Mediterranean in the future, like other this species.

Tab. 1. Some morphometric measurements and meristic counts of puffer fish

Measurements (mm) and counts	*T. filavimaculosus*
Number of specimens	1
Total length (*Lt*)	520
Fork length (L_F)	482
Standart length (*Ls*)	426
Body depth	116
Head length	99
Head width	73
Predorsal length	242
Snout	40
Snout to origin of dorsal fin	205
Snout to origin of pectoral fin	118
Preanal length	242
Prepectoral length	132
Eye diameter	37
Interorbital distance	66
Preorbital length	69
Longest dorsal ray length	52
Longest anal ray length	41
Maximum pectoral fin length	43
Maximum caudal fin length	84
Fin rays	
Dorsal finrays	9
Anal finrays	7
Pectoral finrays	14
Caudal finrays	10

References
1 - Golani D., Orsi-Relini L., Massuti E. and Quignard J.P., 2009. Ciesm Atlas of exotic fishes in the Mediterranean. http://www.ciesm.org/atlas/appendix1.html visited 10/2009
2 - Tortonese E., 1986.Balistidae, Monacanthidae, Ostraciontidae, Tetraodontidae, Diodontidae, Molidae. *In:* Fishes of the north-Eastern Atlantic and the Mediterranean. Whitehead, P.J.P., M.-L Bauchot., J.-C. Hureau, J. Nielsen, & E. Tortonese, (eds.), Paris, UNESCO pp 1335 - 1350.
3 - Froese R. and Pauly D., (eds.) 2009. Fishbase. World Wide Web electronic publication. www. Fishbase.org, version (09/2009)
4 - Golani D., 1987. The Red Sea pufferfish, *Torquigener flavimaculosus* Hardy and Randall 1983, a new Suez Canal migrant to the eastern Mediterranean. (Pisces: Tetraodontidae). Senckenbergiana Marit., 19(5/6): 339-343.
5 - Bilecenoglu M.,2003. Kizildeniz göçmeni balon baligi (*Torquigener flavimaculosus* Hardy & Randall, 1983), Türkiye kiyilarindan ilk gözlemler. *Sualti Dunyasi Dergisi* 74: 38-39. [In Turkish].
6 - Bilecenoglu M., 2005. Observations on the burrowing behaviour of Dwarf Blaasop, *Torquigener flavimaculosus* Hardy & Randall, 1983 (Osteichthyes: Tetradontidae) along Fethiye Coasts, Turkey. *Zool. Mid. East,* 35: 29-34.
7 - Corsini-Foka M., Margies P. Kondilatos G. and Economidis P.S., 2006. *Torquigener flavimaculosus* Hardy and Randall, 1983 (Pisces: Tetraodontidae) off Rhodes island marine areas: a new alien fish in the Hellenic waters Mediterranean *Mar. Sci.*, 7: 73-76.
8 - Hardy G.S. and Randall J.E., 1983. Description of a new species of pufferfish (Tetraodontiformes: Tetraodontidae) from Red Sea and adjacent waters. *Israel J. Zool.*, 32: 13-20.
9 - Hardy G.S., 1984. Redescription of the pufferfish *Torquigener brevipinnis* (Regan) (Tetraodontiformes: Tetraodontidae), with description of a new species of *Torquigener* from Indonesia. *Pac. Sci*., 38: 127-133.

ETUDE DU PLANCTON DE LA ZONE FNIDEQ-OUED LAOU (MEDITERRANEE OUEST MAROCAINE)

O. Ettahiri [1], A. Berraho [1]*, A. Orbi [1], K. Hilmi [1], L. Somoue [1], S. Zizah [1] and S. Charib [1]
[1] Institut National de Recherche Halieutique, 02, Rue Tiznit Casablanca 20 000 Maroc - amina_berraho@yahoo.fr

Abstract
L'analyse du plancton (phytoplancton et chlorophylle 'a', mésozooplancton et ichtyoplancton) dans la zone d'étude a révélé la présence d'une grande richesse planctonique dans la partie Nord comprise entre Fnideq et Cabo Nigro avec une variabilité spatiale des foyers de forte concentration en relation avec la circulation générale dans la zone.
Keywords: Phytoplankton, Zooplankton , Ichthyoplankton, Western Mediterranean

Introduction
Le phytoplancton et le zooplancton jouent un rôle primordial dans le transfert d'énergie vers les niveaux trophiques supérieurs. Certains groupes sont considérés comme indicateurs biologiques des masses d'eaux [1], des changements climatiques [2] ou encore du degré de salubrité des milieux marins [3]. La répartition spatiale de ces deux composantes est généralement synchrone et constitue un milieu favorable pour le développement de l'ichtyoplancton, surtout les larves de poisson. Cette répartition est liée aux conditions hydrodynamiques du milieu, gouvernées par la présence du tourbillon anticyclonique dans la partie occidentale Sud de la Méditerranée [4].

Matériel et Méthodes
Des échantillons d'eau ont été prélevés (du 27 janvier au 07 février 2009) pour le dosage de la chlorophylle 'a', selon un dispositif CTD. Trois niveaux ont été échantillonnés : la surface, à 10 m et le fond. D'autres échantillons d'eau d'un volume de 100 ml ont été prélevés à la surface pour l'étude du phytoplancton. Le zooplancton et l'ichtyoplancton ont été collectés sur toute la colonne d'eau à l'aide d'un filet Bongo de 145µm de diamètre de maille.

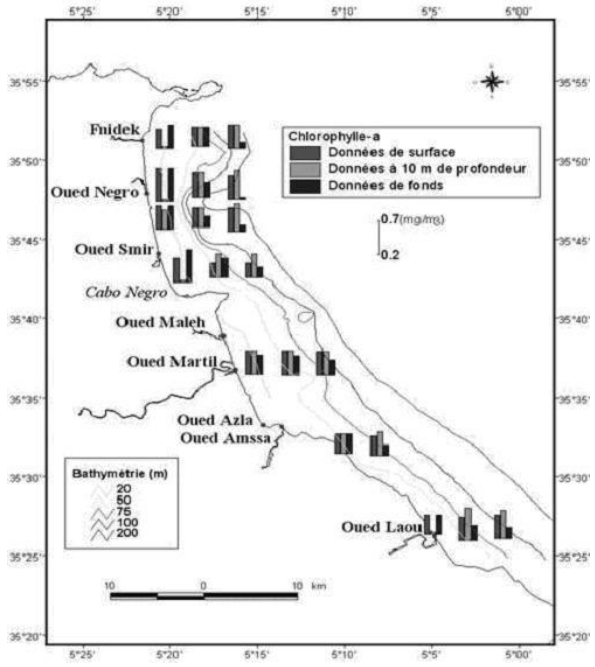


Fig. 1. Distribution de la chlorophylle 'a' à différents niveaux

Résultats et Discussion
L'étude biologique durant cette campagne de mesures a montré que la productivité du milieu, illustrée par la concentration de la chlorophylle 'a', présente une richesse relativement importante, à la fois en surface et au fond de la zone côtière (<50m), comprise entre Fnideq et l'oued Negro, dominée généralement par les eaux atlantiques. Au-delà de l'isobathe 75 m, les concentrations chlorophylliennes diminuent et le sont davantage dans les couches profondes, du fait de l'existence à ce niveau de deux masses d'eaux : l'une en surface d'origine atlantique et riche en chlorophylle 'a' et l'autre méditerranéenne, plus profonde et pauvre en chlorophylle 'a' (Figure 1). Cette situation se reflète également dans l'étude de la densité du phytoplancton de surface dont le maximum de cellules se situe à moins de 75m dans la partie nord de la zone d'étude (Fnideq - oued Smir). De plus, l'accumulation des eaux superficielles au niveau du tourbillon, implique une large épaisseur des eaux pauvres en nutriments (oligotrophes) et une grande pénétration de la lumière. Par conséquent la profondeur à laquelle s'établit le maximum superficiel de chlorophylle (DMC : Depth Maximum Chlorophyl) est importante impliquant une faible productivité biologique [5].
Généralement, la distribution du zooplancton est en relation avec celle du phytoplancton. Toutefois, on observe un certain décalage entre les foyers à fortes concentrations de phytoplancton et ceux à fortes biomasses zooplanctoniques, surtout au nord de la zone d'étude. Etant donné que la composante zooplanctonique est échantillonnée sur toute la colonne d'eau, cette situation est plus justifiée, tenant compte des distributions de la chlorophylle 'a' aussi bien au nord qu'au sud de la zone. La zone d'étude peut être également qualifiée de zone de ponte pour un certain nombre d'espèces, dont la sardine qui représente à elle seule plus de 60% du nombre total des œufs et larves recensés dans la région (Tableau 1). La sardine est une espèce dont la ponte principale se déroule en hiver, ce qui explique la forte abondance des œufs et larves dans la zone (échantillonnage fin janvier). Ainsi, la proximité de la zone d'étude du détroit de Gibraltar, confère surtout à sa partie nord des caractéristiques hydrologiques optimales pour une forte productivité et la ponte des espèces halieutiques. En effet, l'effet fertiliseur du flux d'eau d'origine atlantique est en faveur d'une grande diversité du phytoplancton et aussi du mésozooplancton qui se compose à la fois d'espèces néritiques, pélagiques et celles d'origine atlantique [6]. Toutes ces conditions sont en faveur d'une ponte et de développement larvaires d'espèces halieutiques assez diversifiées.

Tab. 1. Valeurs des différents paramètres biologiques étudiés

		Minimum	maximum	Moyen
Phytoplancton (Cell/l)		200	38000	6225 ± 8478
Mésozooplancton (mg/m3)		1,7	203,4	68,9 ± 49
Ichtyoplancton (Nb/10m²)	Oeufs	0	2202	648 ± 621
	Larves	0	390	99 ± 109

References
1 - Armengol X. and Miracle M.R., 1999. Zooplancton communities in doline lakes and pools, in relation to some bathymetrics parametres and physical and chemical variables. *Plan, Resea*, 21 (12): 2245-2261.
2 - Sournia A., 1995. Red tide and toxic marine phytoplankton of the world ocean: an inquiry in to biodiversity. Proc. 6th Int. Conf. On toxic Marine Phytoplancton. Lavoisier.
3 - Almeida S.F.P., Pereira M.J., Gil M.C. and Rino J.M., Freshwater algae in Portugal and their use for environmental monitoring. Http://www.eau-artois-picardie.fr/laconn/monito-rivers/l.htm.
4 - Gil J., 1994. Circulacion geostrofica e hidrografia del mar de Alboran en la campana ictio. Alboran 0792. *Inf. Téc. Inst. Esp. Oceanogr*. 146 : 9-26.
5 - Rodriguez V., Blanco J. M., Echevarria F., Rodriguez J., Jiménez-Gomez F.y Bautista B., 1994. Nutrientes, fitoplancton, bacterias y material particulado del mar de Alboran, en julio de 1992. *Inf. Téc. Inst. Esp. Oceanogr.* 146 : 53-77.
6 - Giron F., 1963. Copépodes de la mer d'Alboran. (Campagne du "Président-Théodor-Tissier", juin 1957. Rev. Trav. Inst. des Pêches Marit., T. XXVII, Fasc. 4 : 355-402.

REDISCOVERY OF LIVE *GIBBULA NIVOSA* (GASTROPODA: TROCHIDAE)

Julian Evans [1], Joseph A. Borg [1] and Patrick J. Schembri [1]*
[1] Department of Biology, University of Malta - patrick.j.schembri@um.edu.mt

Abstract

Live animals of the trochid gastropod *Gibbula nivosa*, which is endemic to the Maltese Islands, have not been recorded for over 25 years despite recent intensive searches in localities where good populations used to be found. Sampling carried out at Marsamxett Harbour and Comino has yielded live individuals from accumulations of cobbles and pebbles, showing that this is an important habitat for *G. nivosa* and confirming that this species is not extinct, although it should still be regarded as 'critically endangered'.
Keywords: Biodiversity, Conservation, Endemism, Gastropods, Mollusca

Introduction

The Maltese Topshell *Gibbula nivosa* is a critically endangered [1] trochid gastropod endemic to the Maltese Islands [2,3]. Although this species has been reported many times from Malta, it is rare and the last record of live individuals dates back to 1981 [4] despite recent intensive searches for the species in many localities [1]. Given its restricted geographical distribution and rarity, *G. nivosa* is protected under both local and international legislation. Proper conservation and management of this species is necessary to safeguard it but very limited information on its current status exists, a situation that can only be addressed by intensive sampling of the coastline where reported habitats of *G. nivosa* occur. The main habitat for the species is regarded to be leaves of the seagrass *Posidonia oceanica* at depths down to 10m [5], but the gastropod has also been reported from under stones in shallow water [4,6] and fresh empty shells were recently (2006) collected from such a habitat in Marsamxett Harbour, suggesting that live individuals may have been present.

Material and Methods

Surveys of the infralittoral cobble beds in Marsamxett Harbour (Fig. 1) were made in September 2006 and December 2007. Stations were established along the long axis of the cobble beds and three replicate samples were randomly collected from each station at depths of 5-12m, using a 0.1m^2 circular quadrat. The cobbles and pebbles within the quadrat were carefully handpicked and transferred to a 0.5mm mesh-bag, whilst a small hand net was used to scoop the basal layer of finer granules into a separate mesh-bag. In the laboratory, the sediment was sorted by hand, and the collected molluscs were identified and counted. Any *G. nivosa* found were kept alive and returned to their original site of collection. Searches for this species were subsequently carried out at sites in Comino, Qawra Point and St. Thomas Bay, where similar infralittoral cobble and pebble beds occur.

Results and Discussion

Live individuals of *G. nivosa* were collected during both surveys at Marsamxett, with mean abundances of 37.3±78.6SD and 17.6±25.0SD individuals/m^2 recorded in September 2006 and December 2007, respectively. The large variation in abundance, reflected by the high standard deviation, was probably due to the patchy distribution of the species within its habitat, which had a low cover (ca 0.005km^2 only) within the area. The relatively restricted habitat area would support a small total population of *G. nivosa*. The habitat at Marsamxett was characterised by a gently sloping bottom of gravelly sand and silt with overlying accumulations of cobbles and pebbles (modal size: 16-64mm diameter; maximum thickness of pebble layer: 10cm) (Fig.1). This vertical stratification enabled the two layers to be sampled separately, and significantly higher densities of *G. nivosa* were recorded from the upper pebble stratum than from the gravelly sand below (Mann-Whitney U-test, p = 0.018). Two live individuals were collected whilst searching at Comino on a similar bottom type, albeit with a much sparser cover of cobbles and pebbles, at a depth of 18-20m. However, no live animals were found at the other two sites, where the cobbles and pebbles occurred interspersed with *P. oceanica* beds. It is interesting to note that one of these sites, St Thomas Bay, has been regarded as the main locality for *G. nivosa* [4,6].

The present record is the first of live individuals of *G. nivosa* in over 25 years, showing that this species is not extinct and suggesting that other as yet undiscovered populations may exist in some places. Although the main habitat of *G. nivosa* is considered to be *P. oceanica* leaves, in this study live animals have been recorded from infralittoral cobbles and pebbles within Marsamxett Harbour, where the seagrass is not present, indicating that cobble beds may be a more important habitat for *G. nivosa* than previously thought. It is possible that individuals collected from seagrass leaves in the past were only foraging there and actually retreated to the accumulations of cobbles and pebbles (assuming this habitat was interspersed with seagrass beds) when not feeding. However, during this study, no *G. nivosa* were found in either accumulations of cobbles and pebbles interspersed with seagrass beds, or on the *Posidonia* leaves, so more work is required to test this hypothesis. Searches in cobble habitats are necessary for a better knowledge of the current status of *G. nivosa*, which is still regarded as 'critically endangered' under the 2001 IUCN Red List criteria [7].

Acknowledgements: This research work was partly funded through a Malta Government Scholarship Scheme grant (ME 367/07/35) awarded to JE.



Fig. 1. Infralittoral cobbles and pebbles at depths of 5-12m in Marsamxett Harbour, Malta, where *Gibbula nivosa* was found (photo: M. Sciberras)

References

1 - Schembri P.J., Borg J.A., Deidun A., Knittweis L. and Mellado Lopez T., 2007. Is the endemic Maltese Topshell *Gibbula nivosa* extinct? *Rapp. Comm. int. Mer Medit.*, 38: 592.

2 - Ghisotti F., 1976. Considerazioni su *Gibbula nivosa* A. Adams, 1851. *Conchiglie*, 12: 79-88.

3 - Giannuzzi-Savelli R., Pusateri F., Palmeri A. and Ebreo C., 1997. Atlante delle conchiglie marine del Mediterraneo. Vol 1: Archaeogastropoda. La Conchiglia, Rome, Italy, 125pp.

4 - Cachia C., 1981. Notes on some uncommon species of molluscs from the Maltese Islands. *Boll. Malacol.*, 17: 291-294.

5 - Scotti G. and Chemello R., 2000. I molluschi marini mediterranei degni di protezione: stato delle conoscenze e forme di tutela. *Boll. Malacol.*, 36: 61-70.

6 - Cachia C., Mifsud C. and Sammut P.M., 1991. The marine shelled Mollusca of the Maltese Islands, Part One: Archaeogastropoda. Grima Publishing, Marsa, Malta, 112pp.

7 - IUCN, 2001. IUCN Red List categories and criteria: Version 3.1. IUCN Species Survival Commission, IUCN, Gland, Switzerland and Cambridge, U.K., ii + 30pp.

MITOCHONDRIAL DNA SEQUENCE VARIATION IN TUNISIA SARDINE (*SARDINA PILCHARDUS*) STOCKS

Karima Fadhlaoui-Zid [1]*, Soumaya Oueslati [1], Lotfi Ben Abdallah [1] And Othman Jarboui [1]
[1] Institut National Des Sciences Et Technologies De La Mer - Karimafadhlaoui@Yahoo.Fr

Abstract
The genetic diversity and population genetic structure of the Tunisian sardines Sardina pilchardus were investigated. A total 92 individuals were sampled from 3 localities of the coastal zones of Tunisia. Genetic variation in DNA sequences were examined from the cytochrome b (cytb) gene of the mitochondrial DNA. High levels of haplotype diversity were detected, indicating a high level of genetic diversity. Phylogenetic trees demonstrated a divergence between the populations examined in the present study. The knowledge on genetic diversity and genetic structure will be crucial to establish appropriate fishery management stocks for the species.
Keywords: Genetics, Fishes

Introduction
The sardine, Sardina pilchardus (Walbaum, 1792), is an important fish species of great economic importance to Tunisia, as well as to many other countries [1] [2]. For the management and sustainability of fish populations, studying genetic diversity is critical. Nevertheless, studies on the geographic distribution and genetic population structure of many commercial fish species stocks have not been completed [3]. Data concerning sardine populations inhabiting Tunisia coastal waters are currently very limited [4]. To the best of our knowledge the genetic diversity of Tunisia's sardine populations has yet to be investigated using modern DNA technology which is provides suitable markers to examine genetic structure such as mitochondrial DNA.
Mitochondrial (mt) DNA has many attributes that make it particularly suitable for population genetic studies, including its rapid rate of evolution, lack of recombination, and maternal inheritance.
The aim of the present study was to determine whether there is genetic diversity among the sardine populations inhabiting the coastal zones surrounding Tunisia.

Materials and methods
A total of 3 samples of Sardina pilchardus were collected from representative regions along the coastal zones of Tunisia (Gulf of Tunis, Sahel and Gulf of Gabes). For each sample, a fragment of cytochrome b (cytb) gene was amplified by PCR analysis and subsequently sequenced. Sequences of the 307-bp cytb region were aligned using the BioEdit v.7.0.7 program. Haplotype frequencies, gene diversity (h) and pairwise genetic distances (Fst) were calculated with ARLEQUIN vers. 3.01 [5].
Pairwise FSTs genetic distance was used to construct the population phenogram using the neighbor-joining algorithm [6] implemented in Phylip v3.6.1 [7].

Results and discussion
This work provides the first molecular data for the species Sardina Pilchardus along the coast of Tunisia.
Among the 92 specimens studied, 24 different haplotypes were defined by 45 polymorphic sites. Significant heterogeneity in the distribution of haplotypes was revealed between the three populations analysed.
Of the 24 haplotypes, 5 were singletons and of the remaining 19 haplotypes, one was shared among populations.
Haplotype diversity (h) within populations ranged from 0.827 at Gulf of Tunis to 0.910 at Gulf of Gabes. This result demonstrates that Gulf of Gabes is the most diversified.
FST values calculated between populations indicated significant difference ($p < 0.05$) in each pairwise combination of these 3 sampled areas.
The phylogenetic tree constructed using neighborjoining and maximum likelihood methods indicated that population from Gulf of Tunis was closely related to the Adriatic and lonian sardine samples [8], whereas the two other populations were most divergent. The result suggested that the sardine stocks investigated in the present study were from different populations.
Besides the possible contribution of the history and hydrographic barriers, evolutionary processes such as genetic drift and founder effect, and or selection, may have produced the observed genetic differentiation between the populations analysed.

References
1 - Finney, B.P., Gregory-Eaves, I., Douglas M.S.V. and Smol, J.P. 2002. Fisheries productivity in the northeastern Pacific Ocean over the last 2200 years. Nature 416: 729-33
2 - Williams, J.G. 2003. Sardine fishing in the early 20th century. Science 300: 2032.
3 - Atarhouch T, Ruber L, Gonzalez EG et al. 2006. Signature of an early genetic bottleneck in a population of Moroccan sardines (Sardina pilchardus). Molecular Phylogenetics and Evolution, 39, 373–383.
4 - Guizéni S. 2005. Etude allozymique de la différenciation génétique chez quelque populations naturelles de Sardina Pilchadrus du littoral tunisien (Per Comm).
5 - Excoffier L, Laval G, Schneider S. 2005. Arlequin version 3.0: an integrated software package for population genetics data analysis. Bioinform Online 1:47–5
6 - Saitou, N., and Nei, M. 1987. The neighbor-joining method: a new method for reconstructing phylogenetic trees. Mol Biol Evol 4:406–425.
7 - Felsenstein J. 1995. PHYLIP (Phylogeny Inference Package). University of Washington, Seattle.
8 - Tinti, F., Di Nunno, C., Guarniero, I., Talenti, M., Tommasini, S., Fabbri,
E. and Piccinetti, C. 2002. Mitochondrial DNA sequence variation suggests the lack of genetic heterogeneity in the Adriatic and Ionian stocks of Sardina pilchardus. Mar. Biotechnol. 4: 163-72.

FOOD WEB STRUCTURE OF DEEP-SEA COMMUNITIES IN THE BALEARIC BASIN: EVIDENCE FROM $D^{13}C$ AND $D^{15}N$ ANALYSIS

E. Fanelli [1]*, J. E. Cartes [1], V. Papiol [1], F. Maynou [1], P. Rumolo [2] and M. Sprovieri [2]
[1] ICM-CSIC - efanelli@icm.csic.es
[2] IAMC-CNR

Abstract

Food web structure of deep-sea communities off the Catalan Sea (NW Mediterranean) was investigated using carbon and nitrogen stable isotope tracers on a total of 124 taxa. Samples were collected close to Barcelona, between 650 and 1600 m depths, from January 2007 to February 2008. The higher trophic levels were occupied by benthic fish (*Nezumia aequalis* and *Bathypterois mediterraneus*, $d^{15}N$=11.30‰ and 11.36‰, respectively) and infaunal species (carnivores polychaetes such as *Nephthys* spp. and the deposit feeder *Molpadia musculus*). At the lower trophic levels we found *Salpa maxima*, and the pteropod *Cymbulia peroni* (TL=2). The overall range of $d^{13}C$ values was indicative of more than one source of carbon sustaining deep-sea communities: from different kinds of sinking particles to sedimented and frequently recycled POM.

Keywords: Deep Sea Ecology, Food Webs, Western Mediterranean

Introduction

The use of stable nitrogen and carbon isotopes for the study of trophic interactions is now common in aquatic ecosystems. However studies of the trophic web structure of deep-sea organisms are very limited [1,2] and only few were appied to lower trophic levels (benthos, suprabenthos, zooplankton) [3,4]. As part of the Spanish funded **BIOMARE** project, this study is aimed to identify the trophic levels of bathyal communities' dominant species, with particular respect to benthic and zooplanktonic organisms as resources for megafaunal species and to determine the origin of the primary food source and the different sources of food of bathyal ecosystems.

Materials and methods

Samples were collected from cruises sampling megafauna, benthos, zooplankton and suprabenthos off the Catalan Sea slope (Balearic Basin, NW Mediterranean) at depths ranging from 651 to 1600 m. Samples of megafauna and megabenthic, invertebrate epifauna were obtained by trawling the sea floor with a semi-balloon otter trawl (OTSB-14). Macrobenthos (infauna) was collected with box corers, suprabenthos by a MACER-Giroq sledge, while macroplankton, micronekton fauna was obtained by a WP2 net with a system of closure. Once collected samples were frozen at -20°C on board, then sorted in the laboratory, identified to species level and prepared for stable isotope analysis (see [4] and [5] for details on the methodology). A hierarchical cluster analysis was carried out on $\delta^{13}C$ and $\delta^{15}N$ mean values per species and per survey. An ANOSIM test was performed on the same matrix to compare groups identified based on knowledge of gut contents, and then a pair-wise comparison was done on the average $\delta^{13}C$ and $\delta^{15}N$ values of these groups.

Results and discussion

Overall the nMDS analysis separated samples as a function of the trophic level: on the right mainly species belonging to epi/infauna and to megafauna were found, while on the left suprabenthic and macroplankton/micronekton species occurred (Figure 1).

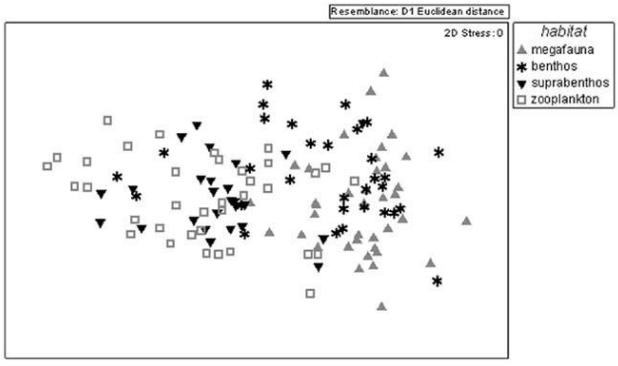


Fig. 1. NMDS plot of the mean $d^{15}N$ and $d^{13}C$ values of 124 taxa

A high complexity were found among each compartment. Epibenthic, invertebrate fauna was organized in three trophic levels based on a ^{15}N-enrichment factor of 2.54‰ per level [6]. $d^{13}C$ ranges were particularly wide among surface deposit feeders (ranging from -21.0‰ to -16.4‰), suggesting exploitation of POM of both terrigenous and oceanic origins.

The same organization was found among macroplankton/micronekton: the lowest values were found for filter feeders which feed on particulate organic matter. Only two trophic levels were found in the zooplanktonic community off Cabrera (Algerian Basin, [4]). $d^{13}C$ ranges were particularly wide among carnivores (from -20.7‰ to -16.6‰), suggesting predation on a variety of prey from gelatinous zooplankton to small fishes and decapods. Three trophic levels were also found among suprabenthos according to [3] and [4], while megafauna occupied TL 3 and 4 with few fish species located at TL=5 (*Bathypterois mediterraneus*, *Phycis blennoides*, *Mora moro*, *Nezumia aequalis*, *Coryphaenoides guentheri*, *Lepidion lepidion*). Generally decapods occupied a lower trophic level than fish, according to [8] and [9], though 2 levels have also been identified.

References

1 - Iken et al., 2001. *Prog. Ocean*., 50: 383-405.
2 - Polunin et al., 2002. *Mar. Ecol. Prog. Ser.*, 220: 13-23.
3 - Madurell et al., 2008. *J. Mar. Syst*., 71, 336-345.
4 - Fanelli, et al., 2009. *Deep Sea Res. I*, 56(9): 1504-1520.
5 - Fanelli & Cartes, 2008. *Mar. Ecol. Prog. Ser*., 355: 219-233.
6 - Vanderklift & Ponsard, 2003. *Oecologia*, 136: 169-182.
7 - Cartes et al., 2007. *Deep Sea Res* I, 54: 1091–1110.
8 - Cartes et al., 2009. *Prog. Ocean*., 82(1): 32-46.

MORTALITE MASSIVE DANS LES PARCS CONCHYLICOLES DE LA LAGUNE DE BIZERTE

Mouna Fartouna Bellakhal [1]*, Meher Bellakhal [1] and Hechmi Missaoui [1]
[1] Institut Supérieur de Pêche et d'Aquaculture de Bizerte. Unité de recherche Exploitation des Milieux Aquatiques, 7003 Tunisie - nephertitim@yahoo.fr

Abstract
Suite à une mortalité massive de moules et d'huîtres au niveau des parcs conchylicoles de la lagune de Bizerte au nord de la Tunisie, un échantillonnage des paramètres physico-chimiques pendant 48 heures, a révélé une élévation inhabituelle de la température de l'eau (29,8°C) et une baisse drastique de l'oxygène dissous (0,64 mg/l). Des expériences en laboratoire ont montré que le facteur déterminant dans cette mortalité est la température.
Keywords: Global Change, Lagoons, Bivalves

Introduction
La lagune de Bizerte, couvrant une superficie de 150 km^2 et située au nord de la Tunisie, constitue un plan d'eau très important du point de vue écologique et économique. Elle est particulièrement propice à la conchyliculture qui ne cesse de se développer, en parallèle avec l'activité de pêche. Les conséquences du changement climatique, qui a touché beaucoup d'écosystèmes sur le globe, ont commencé à se faire ressentir au cours de ces dernières années dans cette lagune. C'est ainsi que des épisodes de mortalité massive de moules et d'huîtres sont devenus assez fréquents notamment pendant la saison estivale. Différents agents, tels que les prédateurs, les parasites, les maladies ou même les conditions environnementales, pourraient également intervenir dans cette mortalité. Cette étude a porté sur l'identification du facteur déterminant dans la mortalité de *Mytilus galloprovincialis*, espèce autochtone de cet écosystème.

Matériels et méthodes 5 stations ont été prospectées toutes les 5h dont 3 (S1, S2 et S3) au niveau de la Société Tunisie Lagune (STL), située au nord-est de la lagune de Bizerte et 2 stations (S5 et S6) au niveau de CUTIMER du côté du canal au nord-ouest de la lagune de Bizerte (37°12´14´´N ; 9° 55´79´´E). Le monitoring des paramètres physico-chimiques de l'eau a été réalisé toutes les 5 heures durant 48 heures, à l'aide d'un multi-paramètres type VWT.

Résultats et discussion: La température moyenne de surface au niveau de la STL est de l'ordre de 27,7 °C, alors que celle du fond est de 26,9 °C. Tandis que les maxima atteints durant la campagne prospective sont respectivement de 29,8°C en surface et de 28 °C au fond. Au niveau de CULTIMER, on a constaté un gradient nettement important entre surface et fond, en effet, la moyenne en surface est de 29 °C, celle du fond est de 24,9 °C. Les teneurs halines sont inférieures à celles citées dans la littérature pour les années précédentes, avec une valeur moyenne de 33 psu au niveau des deux sites d'échantillonnage en surface. Au fond, la salinité est de 33,3 psu. Les valeurs du pH sont homogènes en surface ainsi qu'au fond avec une valeur de l'ordre de 8,3 témoignant d'une influence marine. Toutefois, les concentrations en oxygène au fond sont très fluctuantes et ont atteint une valeur de 0,64 mg/l. Quant aux concentrations en oxygène en surface, elles ont une valeur moyenne de 4.2 mg/l. La teneur moyenne en ammonium est de 0,3 µM et celle en phosphate est 0,6 µM au niveau de la STL. Ces teneurs sont respectivement de 0,2 et 1 µM au niveau de CULTUMER. Des expériences ont été menées au laboratoire, afin d'identifier le facteur déterminant dans la mortalité des moules et des huîtres, Des lots de 100 moules chacun ont été placés dans des aquariums identiques avec une première phase d'acclimatation, un renouvellement total de l'eau toutes les 24 heures, une aération comprise entre 5 et 6 mg/l d'oxygène dissous et des températures croissantes à partir de 25 ° C. La mortalité est apparue au bout de 60 H pour des températures de 27 °C (±0,5 °C). La mortalité totale est survenue après 10 H.

Conclusion : La température élevée et prolongée constitue un stress qui a affecté la capacité de tolérance des moules ce qui a conduit à un affaiblissement physiologique. À cela s'ajoute la forte densité de naissains, les premières mortalités qui accentuent le confinement et favorisent l'activité bactérienne. Ainsi, le concours de tous ces facteurs a abouti à la mortalité des moules. La gestion environnementale des projets aquacoles, de la conception jusqu'à la désaffectation, est une responsabilité partagée par l'industrie, le gouvernement et la recherche.

References
1 - BEJAOUI B., R. BEN CHARRADA, M. MOUSSA, R. BEN HAMADOU, A. HARZALLAH et A. CHAPELLE., 2005. Caractérisation hivernale de la lagune de Bizerte. *Bull. Inst. Natl. Sci. Technol. Mer*, 32, 79-91.

2 - BEN MAHMOUD I., 2003. Influence d'une contamination bactérienne sur le cycle biologique de Mytilus galloprovinvialis (Lmk) dans la lagune de Bizerte. Diplôme d'Etudes Approfondies, Institut National Agronomique de Tunis, 118 p.

3 - CHARMASSON S., E BARKER, A. PRUCHON et H. THÉBAULT., 1999. Long-term variations of man-made radionuclide concentrations in a bio-indicator Mytilus galloprovinvialis from the French Mediterranean coast. *Science Total Environ*., 237, 93-103.

4 - CUSSON M., R. TREMBLAY, G. DAIGLE et M. ROUSSY., 2005. Modeling the depuration potential of blue mussels (Mytilus spp) in response to thermal shock. *Aquacult*., 250, 183-193.

BENTHIC ASSEMBLAGES ON CONCRETE ARTIFICIAL REEFS IN THE NORTHERN ADRIATIC SEA: COMPARISON BETWEEN TECNOREEF® PYRAMIDS AND CUBIC BUNDLES OF TUBES

Federica Fava [1]*, Massimo Ponti [1], Otello Giovanardi [2] and Marco Abbiati [1]
[1] University of Bologna - federica.fava8@unibo.it
[2] Istituto Superiore per la Protezione e la Ricerca Ambientale

Abstract
Benthic assemblages colonising two typologies of concrete artificial reefs (Tecnoreef® pyramids and cubic bundles of tubes), characterised by different shape and material, were investigated three years after their deployment offshore to Po River Delta (northern Adriatic Sea). On both reef types large areas were covered by fine sediments, assemblages where characterised by reef building polychaetes and zoantharian. Assemblages differed among reefs but not between reef typologies, both in term of species abundance and cover percentage.
Keywords: Adriatic Sea, Artificial Reefs, Fouling, Po Delta, Zoobenthos

Introduction
Artificial reefs are manmade structures deployed on sea bottoms with the main aims: protecting and increasing biotic resources by preventing trawling, supporting sessile filter feeders, which can colonise the hard substrata and exploit water column resources, providing nourishment and refuges for motile species, attracting bentho-nectonic fishes ([1], [2]). Sessile and motile species colonise artificial reefs according to complex ecological processes affected by seasonal larval supply, water circulation, turbidity and nutrients, depths, orientation and material of the substrata ([3], [4], [5], [6], [7], [8]). The macrobenthic assemblages colonising two types of concrete artificial reefs modules, Tecnoreef® pyramids and cubic bundles of tubes differing in shape and concrete type, were investigated 3 years after their deployment in the northern Adriatic Sea.

Material and methods
The investigated artificial reefs were deployed in autumn 2006 on muddy bottom 2 nautical miles offshore of Scardovari (Po River Delta, northern Adriatic Sea, 44° 54' N 12° 33' E) at 13-14 m in depth, close to a long-line mussel farm. Reefs included a few dozen of Tecnoreef® pyramids (2 and 3 floors, 1.8 and 2.4 m height), made by 'sea-friendly' certified reinforced concrete manufactured using only natural components without synthetic additives, and cubic bundles of tubes, made by common building reinforced concrete tubes laid on a concrete slab (1.8 m height). The macrobenthic assemblages were investigated during the summer 2009 by means of destructive (scraping off 20x20 cm by hammer and chisel) and digital photographic (17x23 cm) sampling. Four reefs per typology were randomly chosen. For each reefs, 4 destructive and 8 photographic samples were collected. Species were identified to the lowest possible taxonomic level and their abundance was estimated as number of individuals per sample and/or covers percentage estimation, excluding from the pictures dark and blurred zones or portions covered by motile organisms. On pictures percentage cover of sediment was also estimated. Differences between reefs and reef typologies were assessed by uni- and multivariate permutational analysis of variance (PERMANOVA, [9]).

Results
The vertical surfaces of all the reefs were mainly covered by muddy sediments (mean percent cover 57%). Overall, 58 invertebrate taxa were identified in the destructive samples. The most abundant sessile taxa were the reef builder polychaetes (*Sabellaria spinulosa*, *Pomatoceros triqueter* and *Serpula vermicularis*), the zoantharians *Epizoanthus* sp. and the bivalve *Anomia ephippium*. In particular, *Sabellaria spinulosa* colonies, with up to 51 ind. dm^{-2} (means 16.1±5.3 ind. dm^{-2} ± e.s.), built thin crusts of fused tubes from mud, send or shell fragments. Motile fauna was dominated by the muddy tube building amphipod *Corophium acherusicum* and the fossorial polychaetes *Polydora ciliata*. Assemblage structures significantly differed between single structures but not between reef typology (i.e. shape and concrete types), both in term of species abundance and cover percentage. Similar patterns were observed in the distribution of the most abundant species.

Discussion
Both destructive and photographic samplings were able to assess the dissimilarity among single reefs and between reef typologies. No differences in density and/or diversity of the assemblages were detected between Tecnoreef® pyramids support and cubic bundles of tubes. Bio-construction processes on artificial reefs, mainly supported by calcareous algae, is generally favoured under good light conditions and low sedimentation rate ([7]). Here, under high sedimentation rate and reduced lighting conditions, *Sabellaria spinulosa*, with its sand-muddy agglomerates seem to play a relevant bio-construction and strengthening role.

Acknowledgments Research funded by the "Consorzio di bonifica Delta Po Adige" (www.deltapoadige.it).

References
1 - Bohnsack J.A., Sutherland D.L., 1985. Artificial reef research: a review with recommendations for future priorities. *Bulletin of Marine Science* 37: 11-39.
2 - Baine M.S.P., 2001. Artificial reefs: a review of their design, application, management and performance. *Ocean & Coastal Management* 44: 241-259.
3 - Ardizzone G.D., Gravina M.F., Belluscio A., 1989. Temporal development of epibenthic communities on artificial reefs in the central Mediterranean Sea. *Bulletin of Marine Science* 44: 592-608.
4 - Turner S.J., Todd C.D., 1993. The early development of epifaunal assemblages on artificial substrata at two intertidal sites on an exposed rocky shore in St Andrews Bay, NE Scotland. *Journal of Experimental Marine Biology and Ecology* 166: 251-272.
5 - Rodriguez S.R., Ojeda F.P., Inestrosa N.C., 1993. Settlement of benthic marine-invertebrates. *Marine Ecology-Progress Series* 97: 193-207.
6 - Relini G., Zamboni N., Tixi F., Torchia G., 1994. Patterns of sessile macrobenthos community development on an artificial reef in the Gulf of Genoa (Northwestern Mediterranean). *Bulletin of Marine Science* 55: 745-771.
7 - Riggio S., Badalamenti F, D'Anna G., 2000. Artificial reefs in Sicily: an overview. In: Jensen A.C., Collins K.J., Lockwood A.P.M. (eds) Artificial reefs in European Seas. Kluwer Academic Publishers, Dordrecht, pp. 65-73.
8 - Nicoletti L., Marzialetti S., Paganelli D., Ardizzone G.D., 2007. Long-term changes in a benthic assemblage associated with artificial reefs. *Hydrobiologia* 580: 233-240.
9 - Anderson M.J., ter Braak C.J.F., 2003. Permutation tests for multi-factorial analysis of variance. *Journal of Statistical Computation and Simulation* 73: 85-113.

UTILISATION DES PARASITES COMME MARQUEURS BIOLOGIQUES POUR LA DISCRIMINATION DES STOCKS DE *SARDINELLA AURITA* DES CÔTES EST DE LA TUNISIE

Mariam Feki [1]*, Lassad Neifar [2], Lobna Boudaya [2] and Abderrahmen Bouain [2]
[1] Faculté des Science de Sfax, Tunisie
[2] Faculté des Sciences de Sfax, 3018 Sfax, Tunisie - mariamfeki1@yahoo.fr

Abstract
Une étude a été menée afin de déterminer l'utilité des parasites comme marqueurs biologiques pour la discrimination des stocks de l'allache *Sardinella aurita* des côtes Est de la Tunisie. Un échantillonnage de 329 poissons de taille comprise entre 170 et 210 mm a été effectué au niveau de trois stations : Mahdia, Gabès et Zarzis. Des analyses discriminantes, non paramétriques, utilisant quatre taxons parasites, *Parahemiurus merus*, *Aphanurus stossichi*, *Lechithocurium* sp. (Digenea) et les larves de Tetraphyllidea (Eucestoda) ont permis de séparer les allaches du golfe de Gabès (Gabès et Zarzis) de celles du golfe de Hammamet (Mahdia).
Keywords: Stock Assessment, Parasitism

Introduction
Sardinella aurita est une espèce migratrice dont la distribution varie selon les saisons et les stations [1]. C'est une espèce d'une grande importance économique et commerciale en Tunisie. Elle représentait 25% de la production totale des petits pélagiques en 2006 [2]. Pour une gestion durable de cette ressource, l'identification des stocks est indispensable. Au cours de ce travail, les parasites ont été utilisés comme marqueurs biologiques. Ils ont montré leur efficacité pour l'étude des petites et délicates espèces de poissons comme les Clupeidae [3].

Matériel et méthodes
Durant 3 saisons, automne, hiver et printemps, 329 individus de *S. aurita* ont été échantillonnés aux points de débarquements à Mahdia, Gabès et Zarzis. Les coordonnées de pêches ont été soigneusement prélevées avec la collaboration des pêcheurs. Chaque poisson a été examiné afin de rechercher les ectoparasites et les endoparasites. Pour chaque espèce parasite, la prévalence et l'abondance moyenne ont été calculées [4]. Les variations saisonnières et géographiques de ces deux paramètres ont été aussi testées par une analyse discriminante non paramétrique.

Résultats et discussion
Des larves de Tetraphyllidea, au niveau des ceaca pyloriques, trois espèces de Digenea, *Parahemiurus merus*, *Aphanurus stosssichi*, au niveau de l'estomac, et *Lechitochiurim* sp. dans la vessie gazeuse ont été récoltées. L'étude des variations saisonnières de la prévalence et de l'abondance a montré des différences significatives. Les larves de Tetraphyllidea sont plus prévalentes (97,61%, (X^2=29,5 ; ddl=2; p<0,05)) et abondantes (110,45, (X^2=28,03 ; ddl=2; p<0,05)) en automne pour *S. aurita* en provenance de Gabès. *P. merus* présente une prévalence importante pendant l'automne (62,5%) et le printemps (65,85%) au niveau de Mahdia (X^2=26,4 ; ddl=2 ; p<0,05). Ce Digenea est complètement absent en automne à Gabès. *A. stossichi* est plus prévalent au printemps chez les individus en provenance de Gabès (57,14% (X^2=7,03 ; ddl=2 ; p<0,05)) et de Mahdia (60,97% (X^2=63,3 ; ddl=2 ; p<0,05)). En hiver, il est plus prévalent à Zarzis (66,66% (X^2=6,8; ddl=2; p<0,05)). Ces variations de la prévalence et de l'abondance moyenne pourraient être dues à la migration et au changement du régime alimentaire de *S.aurita.* Cette espèce peut effectuer des migrations saisonnières pouvant atteindre des centaines de Km. Ces poissons qui vont se déplacer ont plus de chance d'être en contact avec des parasites [5]. *Lechitochiurim* sp. est complètement absent chez *S. aurita* en provenance de Gabès et Zarzis. On le trouve chez les spécimens en provenance de Mahdia pendant l'hiver et le printemps. Des variations géographiques de la prévalence, sont aussi enregistrées. En effet, *P. merus* est plus prévalent (90%) chez les individus de Zarzis (X^2=111,05; ddl=2; p<0;05). *A. stossichi* est plus prévalent dans le golfe de Gabès (Gabès :52,74% et Zarzis : 58,77%) qu'à Mahdia (20,16%) (X^2=41,56; ddl=2; p<0,05). *Lechitochiurim* sp. n'est présent que chez *S. aurita* en provenance de Mahdia. Les variations géographiques de la prévalence de ces trois Digenea pourraient être expliquées par l'existence de plus d'une population entre le golfe de Gabès et le golfe de Hammamet.

References
1 - Ben Abdallah, L. et. Gaamour, A., 2004. Répartition géographique et estimation de la biomasse des petits pélagiques des côtes tunisiennes. Med Sud Med Technical Documents No.5. pp(28-38).
2 - Anonyme., 2006. Annuaires statistiques de la Direction Générale de la Pêche et de l'Aquaculture (*DGPA*).
3 - Arthur, J.R.; 1997. Recent advances in the use of parasites as biological tags for marine fish. In Diseases in Asian aquaculture III (T. W. Flegel and I. H. MacRae, eds.) Fish Health Section, Asian Fisheries Society, Manila, Philippines. p. 141-154.
4 - Bush, A.O., Lafferty, K.D., Lotz, J.M., Shostak, A.W., 1997. Parasitology meets ecology on its own terms: Margolis et al. revisited. *J. Parasitol.* 83, 575–583.
5 - Lester, R.J.G., MacKenzie, K., 2008. The use and abuse of parasites as stock markers for fish. Fisheries Research. pp 1-2.

DIETARY ACCUMULATION IN WHITE SEABREAM TISSUES OF A SECONDARY METABOLITE FROM CAULERPA RACEMOSA (FORSSKÅL) J. AGARDH

S. Felline [1]*, E. Mollo [2], M. G. Lionetto [1], R. Caricato [1], A. Cutignano [2], F. Regoli [3], S. Gorbi [3] and A. Terlizzi [1]
[1] Dept. of Biological and Environmental Science and Technologies (DiSTeBA), University of Salento - serena.felline@unile.it
[2] Istituto di Chimica Biomolecolare, CNR, I-80078 Pozzuoli, Italy
[3] Dipartimento di Biochimica, Biologia e Genetica, Università Politecnica delle Marche, 60100, Ancona, Italy

Abstract
Our recent observations made on gut contents of *Diplodus sargus*, have highlighted that the algal pest *Caulerpa racemosa* represents an important component of the fish diet along the coast of the Salento Peninsula (SE Italy). Here, we demonstrated that one of *C. racemosa* secondary metabolites, caulerpin, enters in trophic chains and accumulates in fish tissues. Providing a new perspective in the understanding of the effects of biological invasions, the present study represents the starting point for future investigations aimed at evaluating both the potential hazard for long-term effects on the fish, and risks for human health deriving from *D. sargus* consumption.
Keywords: Alien species, Bio-Accumulation, Fishes, Food Webs

Introduction
Secondary metabolites of *Caulerpa* species have been previously investigated to evaluate their ecological role both in chemical defence against herbivores [1] and as allelochemicals in interspecific competition [2]. Our recent observations made on gut contents of *Diplodus sargus*, have highlighted *C. racemosa* as a very important component of the fish diet along the coast of the Salento Peninsula (SE Italy). This study aimed at measuring whether and to what extent the presence of an invasive species in the diet of an endemic fish species can determine accumulation of the algal secondary metabolites in the fish tissues.

Material and Methods
This study is based on a collection of 18 specimens speared in June-September 2008, a period of the year when the abundance of *C. racemosa* reaches its maximum. Each individual was dissected and white and red muscle, liver, skin and the gastrointestinal tract separated. Stomach contents were observed under magnification to assess the abundance of *C. racemosa*. Animal tissues were lyophilized and then exhaustively extracted first with acetone then with ethyl acetate. RP-HPLC-MS analyses were carried out on organic extracts to quantify the accumulation of algal metabolites in fish tissues.

Results and Discussion
The only algal metabolite we were able to detect in *D. sargus* tissues was caulerpin which is the main component of the *C. racemosa* lipophilic extract. The concentrations range between: 0-5.4 µg/g (white muscle), 0-38.2 µg/g (red muscle), 0-14.4 µg/g (skin) and 0-16.3 µg/g (liver). Even though we still do not know if the accumulation of caulerpin is responsible of toxic effects and/or other physiological alterations in the fish, it is reasonable to hypothesize harmful effects on non-adapted fish populations, such as those typical of the invaded systems. This study has represented a baseline on which we have designed an *ad-hoc* experiment, which is based on an integration of chemical, physiological and ecological approaches. Forty-five specimens of *D. sargus* (15 individuals for each of the three locations considered along the Apulian Coasts) have been speared in September-October 2009. Analysis of wide battery of molecular and cellular biomarkers, namely Cat, GPx, TOSC assay, Na^+-K^+-ATPase, VTG, Micronucleus and Comet assay, are currently evaluating the health status of these fishes and their reproductive potential. At the same time, chemical investigations on fish tissues are in progress to value algal metabolites accumulation and to correlate these data with fishes physiological responses. Therefore, through the analyses in progress, we should provide a better understanding of how the *C. racemosa* spreading in the Mediterranean Sea can affect the population dynamics of a single species. Also, we should provide essential information for an effective evaluation of possible risks for human health, deriving from *D. sargus* consumption.

References
1 - Paul V.J., Fenical W., 1987. Natural products chemistry and chemical defence in tropical marine algae of the phylum Chlorophyta. *In*: Scheuer P.J. (ed.), Bioorganic Marine Chemistry. Springer-Verlag, Berlin, pp 1-29.
2 - Raniello R., Mollo E., Lorenti M., Gavagnin M., Buia M.C., 2007. Phytotoxic activity of caulerpenyne from the Mediterranean invasive variety of *Caulerpa racemosa*: a potential allelochemical. *Biol. Invasions* 9: 361-368.

ZOOPLANKTON TEMPORAL PATTERN IN THE WESTERN MEDITERRANEAN: A DECADE STUDY OF TWO TIME SERIES: 1995-2004

Mª Luz Fernandez De Puelles [1]* and MªGrazia Mazzocchi [2]
[1] Stazione Zoologica Anton Dohrn, Villa comunale,80121.Napoli, Italy
[2] Baleares Oceanographic Center, Spanish Institute of Oceanography IEO), Muelle de Poniente s/n 07015 Mallorca, Spain - mluz.fernandez@ba.ieo.es

Abstract
For a 10 year period two Western Mediterranean zooplankton time series (Mallorca Channel and Gulf of Naples) have been analyzed and compared. The environmental seasonal patterns in relation to their main zooplankton groups have been described. No trends were found for temperature, but a salinity increasing trend was observed in the Balearic Sea. Zooplankton was dominated by copepods which, together with cladocerans and appendicularians contributed more than 84% to total. Copepods and cladocerans were more important in Naples, while siphonophores and ostracods were only found in the Balearic Sea. Other minor groups occurred in both areas but during different seasons. Although the period considered may be too short to investigate climate effects, the synchronies observed in the zooplankton suggested common responses to basin-scale signals.
Keywords: Zooplankton , Copepoda, Balear Sea, Tyrrhenian Se, Western Mediterranean

Introduction
The Mediterranean plays a critical role in the global climate system and is one of the most sensitive areas on earth in a global warming context, particularly due to its location at the boundary of two different climate cells and regimes of the temperate and sub-tropical zones (1). On a large scale the Mediterranean could be considered to be a uniform basin representative of the warm temperate region, however it is far from being biogeographically homogeneous, due to its complex morphology with many orographic features and a complex sea floor. The Western Mediterranean (WM), in connexion with the Atlantic through the Straits of Gibraltar, forms a small semi-enclosed basin in which processes are similar to those in the neighbouring ocean, where to study climate or warming effects (2).

Sampling sites and methodology
The sampling sites (St. PA, in the SW of Mallorca island and St. MC in the inner Gulf of Naples) are located at similar latitudes (39º28'59 and 2º25'63; 40º48.5 and14º15, Baleares and Naples respectively), depths (~75m) and coastal proximity (2 nm). However, st. PA is exposed to more offshore waters, located in a boundary area between northern and southern WM waters, st. MC has more coastal character, being heavily influenced by land run-off and a densely populated region at the border between the coastal and offshore waters. **C**omparable methods were used for sampling and analytical methods (3, 4).

Results and Discussion
Seasonal cycle-Temperature pattern was very **s**imilar at both sites and, with the exception of the summer period, was slightly lower in the Balearics (17.07 ºC) than in Naples (17.24 ºC). Salinity, even at the surface, was lower in the Baleares (37.6-37.8) than in Naples (37.9-38.1), excepting the surface during spring.
The pattern of total zooplankton showed that the main difference between the two sites was due to copepods (59% in Baleares and 68% in Naples) but also to cladocerans, (8 and 11%). Appendicularians followed them (17% and 11%) as may to correspond at both different ecosystems (3,4). In lower abundances doliolids and chaetognaths, were present during the first part of the year in Baleares, although mainly present in autumn in Naples. Siphonophores and ostracods were abundant only in the Balearic site as correspond to more oceanic area (3). The most important copepods were *Clausocalanus* and *Oithona* group, but *Acartia clausi*, *Centropages typicus*, *Paracalanus parvus* and *Temora stylifera* were abundant with peaks in different periods of the year. Their relative contributions of these copepods showed interesting differences at the two sampling sites, in relation to differences in the local environmental conditions.
Interannual variability- Temperature showed marked variability with no significant trends. Warmer conditions were observed during 1997 and 1998 in the Balearics and after year 2000 in Naples. Salinity increased in the Balearics during the whole period but no in Naples. The interannual variability of total zooplankton and copepod abundances showed an increasing trend in Naples, that was interrupted after the year 2000. No trend was observed in Baleares. Cladocerans showed marked interannual variability and excepting years 2000 and 2001, lower values in Baleares. Appendicularians did not show clear differences throughout the study period at either both sites. Doliolids and chaetognaths, decreased in Baleares and increased slightly in Naples. Opposite trends were observed for the siphonophores and the ostracods. The most abundant copepods *Clausocalanus* spp., *A. clausi* and *C. typicus* exhibited marked interannual variability at both sites with no clear trend. *Oithona spp.*, *T. stylifera* and *P. parvus* increased in Naples.
The differences recorded in the community composition at groups and species level indicated an strong adaptation to local conditions, nevertheless they had a clear oligotrophic character at the Balearic site and a marked coastal influence at the Naples site.
Although the period considered may be is too short to investigate zooplankton pattern in relation to climate forcing, the synchronies in the zooplankton patterns recorded at both sites points suggested responses of zooplankton to signals at the basin scale. Longer time-series and further analysis have to be encouraged in the Mediterranean as a potential tool to long term evolution of planktonic communities and their responses to climate change.

References
1 - Lionello, P., Malanotte-Rizzoli P., & Boscolo R. (Eds)., 2006. Developments in Earth & Environmental Sciences, 4. Elsevier, Amsterdam. 421 pp.
2 - ICES., 2008. October. Nº 292 Sp. issue. Todd D & O'Brien Eds. ICES, Copenhagen.
3 - Fernández de Puelles, M.L., Alemany, F., & Jansa, J., 2007. GLOBEC Res. Sp. Issue. *Progress in Oceanography*, 74(2-3): 329-354.
4 - Mazzocchi , M. G., & Ribera d' Alcala, M., 1995. ICES *J. Mar. Science* 52: 679-691.

SPATIAL DISTRIBUTION OF HOLOPLANKTON ON THE ANATOLIAN COAST, NERITIC ZONE OF BLACK SEA DURING LATE AUTUMN 2005

Ali Muzaffer Feyzioglu [1]* and Ilknur Yildiz [1]
[1] Karadeniz Technical University, Faculty of Marine Sciences - muzaffer@ktu.edu.tr

Abstract
During the late autumn 2005, holoplanktonic community have been analyzed in Southern waters of the Black Sea. During the sampling period, totally 4 major taxa, which Copepoda, Cladocera Appendicularia and Chaetognatha, were identified. The copepods were the dominant group. Although similarity between the stations were higher than 70 %, three different community structure which fits the Black Sea general current regime were observed during the sampling period.
Keywords: Black Sea, Zooplankton

Introduction
Zooplankton has an important role in aquatic environment in energy transfer to upper trophic level such as fish larvae and other planktivores organisms. Abundance of the zooplanktonic organism is important for efficiency of marine environments. So their abundance and distribution have been widely studied since they first discovered [1]. Zooplankton is divided into 2 main groups as holoplankton and meroplankton. Group spends only a part of their life as a plankton and settling to seabed are called meroplankton. Others, such as copepod and chaetognatha, complete their life cycle as plankton is called holoplankton [2]. They are the permanent members of the pelagic system not only larvae stage but also during the adult stage. In the temporal region like Mediterranean and the Black Sea during the winter period holoplankton are the main components of the zooplankton community. Holoplankton community structure is important component for comparing the regions and the efficiency of secondary production. The aim of the study is to determine the abundance and similarity of the holoplanktonic groups along the Anatolian coast (South Eastern Black sea) neritic zone during the late autumn of 2005.

Materials and Methods
Samples were collected from ten stations located along the South Eastern Black Sea coast during the eight days cruise of R/V DENAR in November 2005 (Fig. 1). Sampling tows were performed at each site using Hensen type closing net with 75 µm mesh size; 70 cm mount diameter, and 220 cm long net. The plankton nets were towed vertically from 50 m depth to surface. The volumes of the sea water filtered were calculated by digital flowmeter (Hydro-bios Kiel, No 439115). The samples were preserved in borate-buffered 4% formaldehyde-sea-water solution until laboratory analysis. Zooplankton samples were removed from the solution and counted under the stereomicroscope [3].

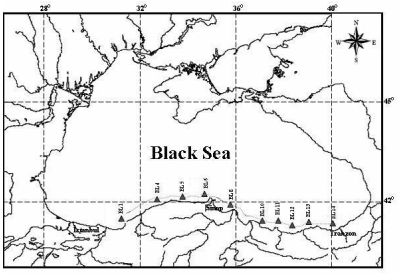


Fig. 1. Sampling location

Result and Discussion
During the sampling period, totally 4 major taxa (Copepoda, Cladocera Appendicularia and Chaetognatha) were identified along the Black sea Anatolian coast. The main and the largest taxa in holoplankton were Copepoda. The most abundance copepod species belonging to the orders of Calanoida and Harpacticoida were *Calanus euxinus, Acartia clausii, Pseudocalanus elongatus, Paracalanus parvus,* cyclopoid copepodlardan *Oithona sp.* and *Tigriopus sp., Laophonte sp.* respectively. Other Crustacea was Cladocera. This taxa includes *Evadne tergestina, Evadne spinifera* and *Penilia avirostris* in the sampling area. In addition to above mentioned, *Oikopleura dioica* and *Sagitta setosa* were only representative for Appendicularia and Chaetognatha respectively. After Copepoda, the Appendicularia (*Oikopleura dioica*) was the second highest biomass in the near shore region. The maximum biomass was observed as 12763 organisms m^{-3} Although the similarities between the stations are higher than 70 %, three different regions distinguish in holoplanktonic community at the Anatolian cost of the Black Sea during the sampling period (Figure 2.B). These are west, middle and eastern Black Sea Regions. The distribution of holoplanktonic communities shows similarities with general Black Sea current regime which has two anti-cyclonic gyros located east and west part of the Black sea. in Ordu off (BL11). Appendicularia was also observed as high as 4837 organisms m^{-3} in Inebolu off (BL 4). It was the highest value for Appendicularia. However the maximum biomass of Chaetognatha was found as 1289 organisms m^{-3} in Unye off (BL 10). Although Cladocera were represented by three species in the region, it was the poorest group. The maximum number of the Cladocera was estimated as139 organisms m^{-3} in the sampling areas (Fig. 2.A).

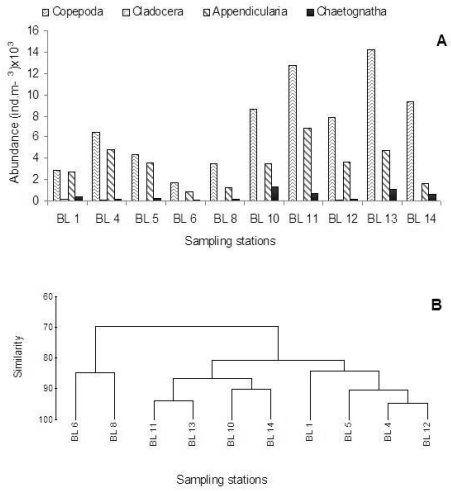


Fig. 2. **A.** Abundance of holoplanktonic organisms **B.** Similarity between the stations

Although the similarities between the stations are higher than 70 %, three different regions distinguish in holoplanktonic community at the Anatolian cost of the Black Sea during the sampling period (Fig. 2.B). These are west, middle and eastern Black Sea Regions. The distribution of holoplanktonic communities shows similarities with general Black Sea current regime which has two anti-cyclonic gyros located east and west part of the Black sea.

References
1 - Gislason A. and Silva T., 2009. Comparison between automated analysis of zooplankton using ZooImage and traditional methodology. *J. Plankton. Res*., vol 31,12:1505-1516.
2 - Kaiser, M J., Attrill, M J., Jennings, S., Thomas, D N., Barnes, D K A., Brierly, A S., Polunin, N V., Raffaelli, D G., Williams, P J. le B., 2005.Marine Ecology: Processes, Systems, and Impacts. Oxford University Pres. New Yourk, 556 p.
3 - Harris, R.P., Wiebe P.H., Lenz,J., Skjoldal, H.J. and Huntley, M., 2000. Zooplankton Methodology Manual, Academic Press, UK. 648 p.

RECENT OBSERVATIONS OF DENSE LIVING COLD-WATER CORAL COMMUNITIES IN THE « LACAZE-DUTHIERS » CANYON (WESTERN MEDITERRANEAN SEA)

A. Fiala [1]*, D. Reyss [1], P. Romans [1], T. Madurell [2], A. Pibot [3], P. Watremez [3], M. Ghiglione [4] and P. Lebaron [1]
[1] Université P.M. Curie (Paris 6) Observatoire Océanologique Banyuls-sur-Mer - afiala@obs-banyuls.fr
[2] Institut de Ciències del Mar, Passeig Marítim de la Barceloneta, 37-49, 08003 Barcelona
[3] Agences des Aires Marines Protégées. 42,Quai de la Douane, 29200 Brest
[4] Mission d'Etude du Parc Marin en côte Vermeille . B.P.5, Passage du vieux Port,66660 Port-Vendres

Abstract
44 years after the discovery of living populations of deep corals in the « Lacaze- Duthiers » canyon, dense populations of corals were observed on its west side . These populations settled either on blocks or cliffs were associated with diverse organisms including sponges, brachiopods, tube worms, echinoderms, oysters, cephalopods and fishes.
Keywords: Biodiversity, Deep Sea Ecology, Western Mediterranean

Altough living deep cold-water coral reefs are well documented in the world oceans (1,2) their presence in the Mediterranean sea has been scarcely reported (3,4). Considered as rare organisms and in decline (5) most of them were dredged dead or in bad shape. The first observation of Mediterrranean living corals was made in the Lacaze Duthiers canyon (1961 and 1963) using the submersible SP350 (Commandant Cousteau) (6) and since then, no more scientific investigations have been performed. During R/V MINIBEX (COMEX) cruises (« MINIBEX » (OOB/DIREN) May-July 2008 ; « MEDSEASCAN » (AMP) november 2008 and june 2009) video surveys using the ROV « ACHILLE » and the submersible « REMORA »(COMEX), have allowed the discovery of new sites colonized by dense living cold water corals populations (Lophelia pertusa, Madrepora oculata, Dendrophyllia cornigera, Desmophyllum dianthus) . Madrepora oculata was observed on blocks or vertical cliffs from 220 to 535m depth colonizing rocks with high densities and large colonies up to 50cm high . Lophelia pertusa with exceptional colonies up to 1m high appeared from 250 to 535m with main abundance between 360 to 535m. Desmophyllum dianthus was also often associated with both species .

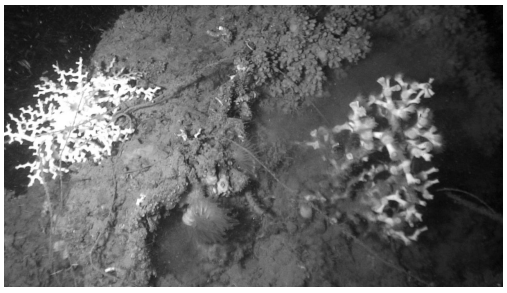


Fig. 1. Lacaze-Duthiers canyon (MINIBEX, May 2008). Living Lophelia pertusa, Madrepora oculata and Desmophyllum dianthus on blocks, 340m.

The yellow coral Dendophyllia cornigera was present with other corals or isolated on rocks till 346m. The coral community was composed of a rich fauna of invertebrates including number of sponges, brachiopods, echinoderms, oysters, ascidians and bryozoans as well as vagil cephalopods and fishes. The populations are structured by both their nutrition with organic particles transported by currents and the sedimentation of mud. Among the identified species, 4 are protected by the French regulation (corals), 13 are cited in European directives 79/109/EEC (Art 4) and 92/43/EEC (Annexe 2), 2 are cited in the OSPAR convention and 13 are of commercial interest.

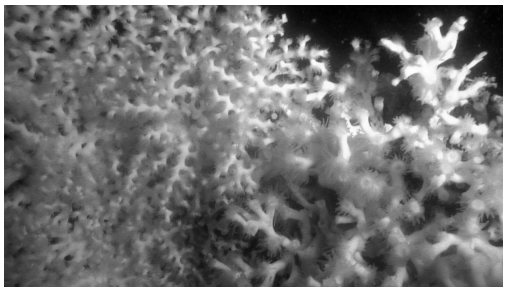


Fig. 2. Lacaze-Duthiers canyon (MEDSEASCAN, June 2009). Lophelia pertusa, Madrepora oculata well opened on a cliff, 363m.

Number of wastes, not observed in the first dives (1961 and 1963) were also observed including fishing nets and lines, boots, cans, glass bottles and plastic bags. These observations will allow to implement this canyon with a deep observatory dedicated to deep experiments. Habitat mapping and conservation programs will allow the long-term monitoring of these coral populations.

Acknoledgments : are due to H. Zibrovius for confirmation of the coral species and the « MINIBEX » , «ACHILLE » and « REMORA » crews.

References
1 - Holland M., 2008. Deep waters coral reefs . Unique biodiversity Hot-spots. Springer,Praxis Publishing Chichester, UK,278p.
2 - Murray R., Wheeler A. , Freiwald S. Cairn S., 2009. Cold waters corals. Cambridge University Press, 334p.
3 - Taviani M., Freiwald A., Zibrovius H., 2007. Deep coral growth in the Mediterranean sea, an overview. In : Freiwald A., Roberts M. (Eds). Cold-Water Corals and Ecosystems. Springer Berlin, Heidelberg : 137-156.
4 - Freiwald A., Beuck L., Rüggeberg A., Taviani M., Hebbeln D. and R/V Meteor cruise M70-1participants , 2009. "The White Coral Community in the Central Mediterranean Sea Revealed by ROV Surveys", *Oceanography* Vol. 22(1) : 58-74.
5 - Scembri P.J., Dimech M., Camilleri M., Page R., 2007. Living deep-water Lophelia and Madrepora corals in Maltese waters (Straight of Sicily, Mediterranean Sea). *Cah Biol. Mar*.,48 :77-83.
6 - Reyss,D., 1964.Observations faites en soucoupe plongeante dans deux vallées sous-marines de la mer Catalane : le rech du Cap et le rech Lacaze-Duthiers. *Bull.Inst. Océanogr* ,63 (n°1308): 1-8.

FIRST RECORD OF THE CANARY DRUM *UMBRINA CANARIENSIS*VALENCIENNES, 1843 (PISCES, SCIAENIDAE) IN THE SICILIAN CHANNEL (CENTRAL MEDITERRANEAN)

F. Fiorentino [1]*, M. Dimeck [2], G. Giusto [1], U. Morara [1], M. Zaccaria [1], A. Titone [1] and B. Zava [3]

[1] Istituto per l'Ambiente Marino Costiero - Consiglio Nazionale delle Ricerche - V- L. Vaccara 61 - 91026 - Mazara del Vallo (TP) - Italy - fabio.fiorentino@iamc.cnr.it

[2] Malta Centre for Fisheries Sciences Fort San Lucian Marsaxlokk BBG 1283, Malta

[3] Wilderness studi ambientali, via Cruillas 27 90146, Palermo, Italy

Abstract

A juvenile of the Canary drum *Umbrina canariensis* was caught in the Sicilian Channel extending the area of occurrence of the species. The specimen was found between 140 and 171 m depth on the eastern side of the Malta Bank. This finding represents the easternmost record of the species in the Mediterranean, confirming the role of the Sicilian Channel as the biogeographic boundary between the western and eastern Mediterranean.

Keywords: Fishes, Biogeography, Sicilian Channel

The Canary drum *Umbrina canariensis* Valenciennes, 1843 occurs on the shelf and upper slope at 50 to 300 m depth on muddy and sandy bottoms in the eastern Atlantic Ocean and western Mediterranean Sea [1]. In the Mediterranean it has been recorded from the Alboran Sea, the Catalan Sea and off Maiorca [2], along the Algerian coast [3], and in north-western Tunisia [4]. Following [5], the presence of the Canary drum in Sicily was also reported [6], but a more careful reading of the Doderlein's paper allows us to interpret this finding as the specimen of *U. ronchus* Valenciennes, 1843, found off Messina by Giglioli [7]. Our fish was a juvenile male of 177 mm total length caught on June 19th 2004 (MEDITS trawl survey) between 140 and 171 m depth on the eastern side of the Malta Bank (approximate position 36 03.26 N; 15 16.63 E). Table 1 shows the main biometrics and meristics of the collected specimen.

Tab. 1. Main biometries and meristics of the examined specimen (L=length and D= depth)

Total L	Standard L	Head L	Body D	Eye diameter
177	145	42.2	49.5	12.5
Caudal peduncle D	Interorbital width	L of lt anal ray	1st dorsal fin	2nd dorsal fin
13	17	17.9	X	H28
Anal fin	Pectoral fin	Pelvic fin	Caudal fin	Gill rackers on 1st gill arch
II+8	16	6	18	16

This finding is the first documented occurrence of *U. canariensis* in the Sicilian Channel and the easternmost record in the Mediterranean, confirming the role of the Sicilian Channel as the biogeographic boundary between the western and eastern Mediterranean [8].

References

1 - Chao L. N., 1986. Sciaenidae. *In*: Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J., and Tortonese E. (eds.), Fishes of the North-eastern Atlantic and the Mediterranean. Volume II, Unesco, Paris, pp 865-876.

2 - Recasens L., Lombarte A. and Sánchez P., 2006. Teleostean fish assemblages in an artificial reef and a natural rocky area in Catalonia (Northwestern Mediterranean): An Ecomorphological Approach. *Bulletin of Marine Science*, 78(1): 71–82.

3 - Djabali F., Brami B. and Mammasse M., 1993. Poissons des cotes algeriennes. Bulletin de l'Institut des Sciences de la Mere et de l'Aménagement du Littoral. Ministere delegue aux Universites et a la Recherche Scientifique, pp 1-215.

4 - Bradai M. N., Quignard J.P., Bouain A., Jarboui O., Ouannes-Ghorbel A., Ben Abdallah L., Zaouali J. and Ben Salem S. 2004. Ichtyofaune autochtone et exotique des côtes tunisiennes recensement et biogéographie. *Cybium*, 28 (4) : 315 – 328.

5 - Doderlein P., 1889. Manuale ittiologico del Mediterraneo ossia sinossi metodica delle varie specie di pesci riscontrate sin qui nel Mediterraneo ed in particolare nei mari di Sicilia. Fascicolo IV. Teleostei Acantotterigi Perciformi. Tipografia del Giornale di Sicilia, Palermo, pp 1-188.

6 - Trewavas E., 1973. Sciaenidae. *In*: Hureau J.C. and Monod Th. (eds.), Clofnam I. Check-list of the fishes of the north-eastern Atlantic and the Mediterranean. Unesco, Paris, pp 396-401.

7 - Giglioli E. H., 1882. New and very rare fish from Mediterranean. *Nature*, 25: 535.

8 - Bianchi C.N., 2007. Biodiversity issues for the shortcoming tropical Mediterranean Sea. *Hydrobiologia*, 580: 7-21.

DIVERSE OLIGOHALINE FORAMINIFERAL FAUNA AT ENOT TIMSAH, ISRAEL

Shunit Flako-zaritsky [2], Ahuva Almogi-labin [3], Bettina Schilman [3] and Chaim Benjamini [1]*
[1] Department of Geological and Environmental Science, Ben Gurion University of the Negev; Ramon Science Center - chaim@bgu.ac.il
[2] Department of Geological and Environmental Science, Ben Gurion University of the Negev; Geological Survey of Israel
[3] Geological Survey of Israel

Abstract
The Enot Timsah spring system feeds an endangered wetland ecosystem at the foot of the Carmel Mountains. The site studied is isothermal, oligohaline (3-4 psu) and highly oligotrophic. Foraminiferal diversity consists of 15 live species and 3 more in the dead assemblage, reflecting a uniquely diverse marginal system. Richness is attributed to thermal stability, maturity dating to early Holocene, and position beneath bird migration routes. Low numbers, mainly of agglutinants, live in the top 4 cm. The dead assemblage is more numerous but records significant taphonomic loss of agglutinants and durability of hyalines; miliolid representation is unaffected.
Keywords: Biodiversity, Brackish Water, Eastern Mediterranean, Foraminifera

Introduction
The Enot Timsah nature reserve is located at the foot of the Carmel Mountains ~2.5 km from the Mediterranean. It constitutes the only significant natural outlet of the mountain aquifer system, and is the last remnant of the extensive Kebara wetlands, drained in the early 20th century. We here address the living foraminiferal assemblage that inhabited this ecosystem, as well as the dead assemblage that time-averages out patchiness and informs on taphonomic changes that allow comparison with the geologic record.

Material and Methods
The sampling station was located in an undisturbed spot in the Timsah reserve downstream from an active spring (32°33'9N/34°55'41E). Foraminifera were sampled monthly over one year in 2002-3. Temperature, conductivity, pH, major ion and nutrient concentrations of the water were determined. Sediments were taken using a 100 ml syringe to 4 cm depth. Living foraminifera were stained with Rose Bengal and preserved in 95% ethanol. Living and dead foraminifera >63µm were counted from 5 sets each from 8 sampling events.

Results and discussion
Enot Timsah is a unique ecosystem representing a ground/surface water interaction zone with very stable water properties. The system is nearly isothermal with temperature averaging 23.98±0.42 °C. It is oligohaline, with total dissolved solids (TDS) averaging 3,213.6±118.5 mg/l. pH averaged 7.05±0.15, in equilibrium with the carbonate aquifer source. PO_4^{3-} is the limiting nutrient in concentrations indicating oligotrophy. Organic carbon averaged 8.8±2.8 wt% with C/N ratio of ~14. Sediment is silty sand and % $CaCO_3$ is ~40%. Living foraminiferal abundance was 3 to 32 specimens/10 cc in the top 4 cm, much lower than in other oligohaline environments. Low numbers reflect the extremely low salinity, at the lower range for survival for most foraminifera, and the extreme oligotrophy, reflected by the high N/P, that limited phytoplankton production. 15 living and additional 3 dead species were recovered, comprising 8 agglutinants, 6 miliolids and 4 calcareous hyalines. This number of species is significantly higher than other environments of low salinity (Fig. 1). Occurrence of hyaline and miliolid taxa in oligohaline systems is atypical, and probably reflects the warm water and the high, stable Ca^{2+} and HCO_3^- concentrations contributed by the carbonate aquifer source. This wetland is located along the main migratory route of water fowl between Eurasia and Africa, so repetitive avian transport of cosmopolitan brackish foraminifera explains the high diversity. Also contributory is the long-term stability of temperature and salinity compared to marginal marine environments, as no significant change took place during the Holocene. Agglutinants comprise 49-80% of the living assemblage, hyalines 10-43%, and miliolids, 5-13%. The most common species are *Haplophragmoides manilaensis, H. wilberti* and *Trochammina inflata* that are low salinity indicators known from brackish environments. Others include *Birsteiniolla macrostoma* and *Pseudothurammina limneti*. Among miliolids, the shallow marine species *Affinitrina eburnea* is most common. Hyaline forms include *Cribroelphidium* cf. *C. vadescens* and *Trichohyalus aguayoi*. *Ammonia tepida* is present in small numbers. Noteworthy is relative abundance of *Bisaccium imbricatum*, a species recorded to date only from Louisiana. Foraminifera in the dead assemblage are more numerous. Hyalines are 2-6 times more abundant than in the living assemblage, while agglutinant numbers are sharply reduced. Among hyalines *A. tepida* abundance rises significantly. Miliolids comprise 5-13% of dead forms, similar to the living assemblage. The main control on taphonomic change is not the pH of 7.1, as calcareous miliolids and hyalines are more susceptible to dissolution than organic-cemented agglutinants. Selective preservation of calcareous tests is due mainly to the high HCO_3^- content and the $CaCO_3$-rich sediments, while decrease in agglutinants is due to extreme fragility of some tests, combined with microbial degradation of the organic cement.

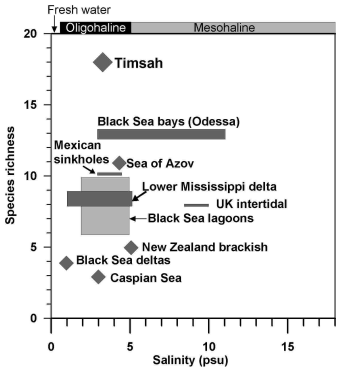


Fig. 1. Comparison of species richness in selected oligohaline (0.5-5 psu) and mesohaline (5-18 psu) settings. Values are high at Timsah, Black Sea, and Sea of Azov where salinity is more stable than in salt marshes and estuarine settings. Records were [1] for the lower Mississippi delta; [2] for the Black and Caspian seas and Sea of Azov; [3] for New Zealand brackish environments; [4] for UK intertidal zone; [5] for Mexican sinkholes

References
1 - Scott, D.B., Suter, J.R. and Kosters, E.C., 1991. Marsh foraminiferal and arcellaceans of the lower Mississippi Delta: Controls on spatial distribution. *Micropaleont.*, 37: 373-392.
2 - Yanko, V., 1990. Stratigraphy and paleogeography of the marine Pleistocene and Holocene deposits of the southern seas of the USSR. *Mem. Soc. Geol. Ital.*, 44:167-187.
3 - Hayward, B.W, Grenfell, H.R., Reid, C.M. and Hayward, K.A., 1999. Recent New Zealand shallow-water benthic foraminifera: Taxonomy, ecologic distribution, biogeography and use in paleoenvironmental assessment. Inst. Geol. and Nuclear Sci., Monograph 21: 264 p.
4 - Horton, B.P., Edwards, R.J. and Lloyd, J.M., 1999. UK intertidal foraminiferal distributions: implications for sea-level studies. *Mar. Micropaleont.* 36: 205-223.
5 - Van Hengstum, P.J., Reinhardt, E.G., Beddows, P.A., Huang, R.J. and Gabriel, J.J., 2008. Thecamoebians (Testate Amoebae) and foraminifera from three anchialine cenotes in Mexico: Low salinity (1.5–4.5 psu) faunal transitions. *J. Foram. Res*., 38: 305-317.

IN LESS THAN 10 YEARS THE SQUAT LOBSTER *MUNIDA RUTLLANTI* HAS REPLACED *M. INTERMEDIA* IN THE WESTERN POMO PIT (CENTRAL ADRIATIC)

Carlo Froglia [1]*, Maria Emilia Gramitto [1] and Elisabetta Betulla Morello [1]
[1] ISMAR - CNR - c.froglia@alice.it

Abstract
Munida rutllanti was recorded for the first time in the central Adriatic in 2003 and today has almost completely replaced *M. intermedia*, ranking second by weight in the benthic decapod crustacean assemblage of the western Pomo pit.
Keywords: Decapoda, Adriatic Sea, Global Change

The "meso-Adriatic depression" (Pomo pit) is an important trawling ground for the Adriatic fishing fleet. *Munida intermedia* was, initially, the only squat lobster recorded in benthic decapod crustacean assemblage of the area, ranking second by weight after *Nephrops norvegicus* [1]. *Munida iris rutllanti* Zariquiey Alvarez 1952 was first described from the Alboran Sea (off Melilla). Since then, in the Mediterranean, it has been reported from the Alboran, Catalan and Northern Aegean Seas only, despite its distinctive characters and the numerous fishery surveys carried out throughout the western and central Mediterranean since the 1970s. In 2000 it was first collected in small numbers in the Southern Adriatic [2] and Eastern Ionian Seas [3]; and in June 2003 it was recorded for the first time in Pomo Pit when, already, it outnumbered *M. intermedia* [4]. Since 2003, the population of *M. rutllanti* has been opportunistically monitored and some aspects of its biology investigated and compared with information already available for *M. intermedia* [5]. *Munida intermedia* was absent in most of the hauls of the May 2009 trawl survey, the ratio *M. intermedia* / *M. rutllanti* was 1: 150 (TAB 1) whilst the overall abundance of squat lobsters in the decapods assemblage remained substantially unchanged. In the Pomo pit the two species reach similar maximum sizes and the smallest ovigerous females are around 8 mm CL for both; despite this, their reproductive strategies are different. *Munida rutllanti* spawns in late-spring and summer and is a multiple spawner, as shown by the large number of females carring embryos ready to hatch, and having mature turquoise ovaries visible trough the cuticle. *Munida intermedia*, on the contrary, spawns in winter and is a single spawner The fecundity of the single batch of a female of *M. rutllanti* is higher than that of *M. intermedia* of the same size. Furthermore *M. rutllanti* is far less subject to parasitization by Rhizocephalans compared to *M. intermedia* (TAB. 1). Most Rhizocephalans are known to alter the reproductive success in a population by inducing castration of the host. Fishing trials carried out in 2004 [6] revealed that creels selectively caught *M. intermedia* compared to *M. rutllanti* (4:1) whilst the opposite was true for bottom trawl catches (1:4). This is suggestive of the fact that the two species may also have different feeding strategies.

Tab. 1. Composition of the squat lobsters popolation in the Western Pomo pit in the period 1997-2009 and percentage of parasitization by Rhizocephalans in the two species of *Munidia*

Year	1977	1993	1998	2003	2004	2005	2009
N. Squat lobster examined	786	2943	3174	733	8049	1206	1951
M. intermedia / *M. rutllanti*	1 / 0.0	1 / 0.0	1 / 0.0	1 / 3	1 / 5	1 /12	1 / 150
M. intermedia % parasitized	35.2	14.5	X	26.6	37.6	40.2	39
M. rutllanti % parasitized	-	-	-	0.6	0.3	< 0.1	0.1

The capacity of *M. rutllanti* to outcompete *M. intermedia* is probably related to its life history, but climate warming and the effect of the Eastern Mediterranean Transient on overall Mediterranean circulation [7] could be at the origin of this recent spreading.

References
1 - Froglia C. and Gramitto M.E., 1995. Crustacea Decapoda assemblage of the Western Pomo pit: I. Specific composition. *Rapp.Com.int.Mer Medit.*, 34:29.
2 - Ungaro N., Marano C.A., Ceriola L., and Martino M., 2005. Distribution of demersal crustaceans in the southern Adriatic Sea. *Acta Adriat.*, 46:27-40.
3 - Politou C.-Y., Kavadas S., Mytilineou Ch., Tursi A., Carlucci R. and Lembo G., 2003. Fisheries resources in the deep waters of the eastern Mediterranean (Greek Ionian Sea). *J. Northw. Atl. Fish. Sci.*, 31:35-46.
4 - Froglia C. and Gramitto M.E., 2005. Will *Munida rutllanti* (Zariquiey, 1952) replace *Munida intermedia* (Milne Edwards & Bouvier, 1899) (Decapoda: Galatheidae) in the central Adriatic trawling ground? *Book of Abstracts, 6th International Crustacean Congress*: 88.
5 - Gramitto M.E. and Froglia C., 1998. Notes on the biology and growth of *Munida intermedia* (Anomura: Galatheidae) in the western Pomo pit (Adriatic Sea). *J. Nat. Hist.*, 32:1553-1566.
6 - Morello E.B., Antolini B., Gramitto M.E., Atkinson R.J.A. & Froglia C., 2009. The fishery for *Nephrops norvegicus* (Linnaeus, 1758) in the central Adriatic Sea (Italy): a comparison between bottom trawl and baited creels. *Fish. Res.*, 95:325-331.
7 - CIESM., 2008. Climate warming and related changes in Mediterranean marine biota [F. Briand, Ed.]. *CIESM Workshop Monographs*, 35: 152 pp.

CONTRIBUTION TO THE DIETARY ANALYSIS OF THE SQUID *ILLEX COINDETII* (CEPHALOPODA, OMMASTREPHIDAE) AT THERMAIKOS GULF (NORTH AEGEAN-GREECE)

K. Fryganiotis [1]*, M. Margaritis [1], C. Antoniadou [1], P. Damianidis [1] and C. C. Chintiroglou [1]
[1] Department Of Zoology, School Of Biology, Aristotle University, Thessaloniki,Greece - kfrygani@bio.auth.gr

Abstract
The dietary analysis of the squid *Illex coindetii* was carried out at Thermaikos Gulf. Samples were collected seasonally by bottom trawl during one permitted fishing period. The species preyed mostly on crustaceans, cephalopods and fishes. The composition of its diet differed according to the season and the animal's sex and size. Female and large-sized individuals preferably consumed crustaceans. Similar results have been reported from *I. coindetii* populations at the same geographic area, but the dietary composition of the squid is different at other Mediterranean populations. These results reveal the increase variability of the species' trophic habits.
Keywords: Diet, Cephalopods, Aegean Sea

Introduction
The squid *Illex coindetii* (Verany, 1839) is an Atlanto-Mediterranean species, inhabiting various soft substratum types, mostly muddy bottoms, with a broad vertical distribution, from shallow waters up to 1000 m depth [1, 2]. The species is very common throughout the Mediterranean and in several areas of the Aegean Sea [1]. Due to its commercial interest and also to its wide range of distribution, there are many studies about the species' biology, fisheries and natural stock management [2]. In particular, the diet of the squid has been described revealing significant differences according to the geographic area, the sex, the season and the size of the animal [2]. Therefore, the present study aims at describing the trophic habits of *I. coindetii* at Thermaikos Gulf, by presenting preliminary data about the influence of sex, season and mantle length to its diet.

Materials and Methods
The study was carried out at Thermaikos Gulf (north Aegean Sea, Eastern Mediterranean). Seasonal samples were collected using commercial bottom trawl, during one permitted fishing period (October 2005 to April 2006). 21 hauls were carried out (mesh size of the net: 40 mm) at depth ranging from 32 to 96 m. All the collected squids were measured for mantle length and their stomach content was examined. The trophic level of the squid [3] and two trophic indices ([4], [5]) were estimated: the frequency of occurrence, F and the percentage of prey, P, calculated as follows $F=n*100/N_s$ and $P=n_1*100/N_p$, where n= number of stomachs containing a certain prey, N_s= total number of stomachs examined, n_1= total number of individuals of a certain prey andN_p= total number of prey items. According to N values, prey categories were distinguished as preferential (N>50%), secondary (10%<N<50%) and occasional (N<10%) [3, 4]. ANOVA analysis was used to test for the effects of sex, season and size to the stomach content of the squids.

Results and Discussions
In general, 200 specimens of *I. coindetii* were collected, almost exclusively in daytime, and examined. According to the calculated indices, these squids prayed preferably on crustaceans (F=29.5%, N=54,13%), cephalopods (F=13%, N=23,85%) and fishes (F=12%, N=22,02%), whereas a significant percentage of squids presented empty stomachs (up to 50%). The percentage of each food item is given at Table 1. The trophic level of *I. coindetii* was estimated at 3.94 (S.E=0.59). ANOVA results showed that prey composition differed among seasons, sex, and size (P<0.05). Large sized individuals and females consumed increased amount of all three food items. With respect to the seasonal differences, the consumption of Crustacea decreased in autumn, whereas that of Cephalopoda and Pisces increased in spring.

Tab. 1. Ratio of stomach content of Illex coidetii by sex, season and size (ML=mantle length of cuttlefish)

Stomach content	Percentage of prey (%)						
	Male	Female	Autum	Winter	Spring	ML≤69,3	ML>69,3
crustaceans	25.7	33.3	20.4	33.8	32.1	24.8	34.7
cephalopods	10.9	15.1	11.1	5.9	20.5	9.5	16.8
pisces	8.9	15.1	9.3	11.8	14.1	8.6	15.8
Empty	55.1	63.7	66.7	61.8	52.6	64.8	53.7

The above results conform to other studies conducted at the north Aegean Sea [1]. In contrast, the main prey items at the western Mediterranean populations of the squid are fishes, followed by crustaceans and to a much lesser extent, cephalopods [2]. Also, at these areas the predominance of fishes over crustaceans is higher in spring and autumn than in winter. At the present study a very high percentage of cephalopods in prey composition was observed. This result may be attributed to the relatively small size of the collected squids, since cephalopods are considered as occasional prey for *I. coindetii*, being consumed mostly by juveniles [1, 2]. It seems therefore, that the species can utilize a variety of food items, according to prey availability, size, sex and season.

References
1 - Vafidis D., Koutsoubas D., Chartosia N. and Koukouras A., 2008. The Teuthoidea (Cephalopoda, Molluska) fauna of the Aegean Sea: comparison with the neighbouring seas and notes on their diet composition. *J.Biol.Res.*, 10:191-205.
2 - Sánchez P., González A.F., Jereb P., Laptikhovski V.V., Mangold K. M., Nigmatullin Ch.M. and Ragonese S., 1998. Squid recruitment dynamics: the genus *Illex* as a model, the commercial *Illex* species and influences on variability. In: Rodhouse PG, Dawe EG, O'Dor RK, eds. *Illex coindetii*. FAO Fisheries technical paper, no 376 pp. 59-76.
3 - Pauly D., Froese R., Sa-a P., Palomares M.L., Christensen V. & Rius J., 2000. TrophLab manual. ICLARM. Manila, Phillipines.
4 - Hyslop E.J., 1980. Stomach content analysis – a review of methods and their applications. *Journal of fish biology*, 17: 411-429.
5 - Williams M.J., 1981. Methods for analysis of natural diet in portunid crabs (Crustacea: Decapoda: Portunidae). *Journal of experimental marine biology and ecology*, 52: 103-113.

PATTERNS OF BIOINVASION IN THE MEDITERRANEAN SEA – MANAGEMENT AND MISMANAGEMENT

Bella s. Galil [1]*

[1] National Institute of Oceanography, Israel Oceanographic & Limnological Research, POB 8030, Haifa 31080, Israel - bella@ocean.org.il

Abstract

The synthesis of data on Mediterranean alien species' native region, human-mediated transfer mechanisms and spatial and temporal occurrence, generate "apparent patterns" of invasion: (a) most species have been introduced through the Suez Canal; (b) most species occur in the Levant; (c) their native region and vector differ greatly among basins; (d) more rapid and extensive geographical spread in the past two decades; (f) apparent rate of invasion corresponds to shifts in vectors, alterations of recipient regions, and sporadicity of research efforts. Climate change is a significant factor. The challenges for environmental management are discussed.

Keywords: Alien species, Global Change, Suez Canal

Six hundred-and-twenty metazoan species are recorded as alien in the Mediterranean Sea [1]. All are littoral and sublittoral benthic or demersal species (or their parasites). Their native range is most commonly the Ind- Pacific Ocean, Indian Ocean, and the Red Sea. The majority entered through the Suez Canal (54%), with additional 10% primarily introduced through the Canal and then transported by vessels. The means of introduction differ greatly among the phyla and among basins. The numbers of alien species which have been recorded in the Mediterranean each decade over the past century have increased in recent decades. The figure reflects political crises, economic development and scientific interest in recording marine alien species. The inventory of the alien species in the Mediterranean provides us with data that allows examination of the efficacy of regulatory instruments and environmental management options either in place or soon to be. Due to the high permeability of aquaculture facilities, transport and transplantation of farmed alien species in the 1970s and 1980s markedly increased the number of intentionally and unintentionally introduced species. The impact of the voluntary guidelines, the restriction of importation due to self-sustaining spat production and the realization by the industry that the imported species may arrive with their complement of parasites and pathogens, led to institution of "zoosanitary precautions" that have already contributed to a reduction in the numbers of mariculture-associated alien species. Still, segments of the industry resort to illegal importations: a bilaterally ablated female banana prawn, *Fenneropenaeus merguiensis*, was collected in the Bay of Iskenderun, Turkey, in late 2006 [2]. Because eyestalk ablation is commonly used in aquaculture to induce maturation of gonads, there is no doubt that specimen escaped or was released from a nearby aquaculture facility. However, neither the Turkish authorities nor FAO have been aware of the importation of that species. A great number of alien species in the Mediterranean Sea have been vessel-introduced and vessel-dispersed. The International Maritime Organization (IMO) sponsored an international instrument to regulate ballast water management which was adopted by a Diplomatic Conference in 2004, but only 20 contracting states have signed on (www.imo.org). Assuming that the Convention will be ratified and implemented, the number of ballast-transported aliens maybe reduced. However, hull fouling, long acknowledged as a dominant vector of transport of alien biota, may soon be on the increase as a result of the implementation of another IMO Convention: the International Convention on the Control of Harmful Anti-Fouling Systems on Ships, which calls for a global prohibition on the application of organotin compounds, entered into force in 2008 (www.imo.org). Alternative ship coating recently introduced as a substitute to TBT based antifouling paints may not be as effective, possibly resulting in more species being transported, and the number of introductions by hull fouling may increase significantly [3]. The increasing role of the Mediterranean as a hub of international commercial shipping has been reflected in the growing number of vessel-introduced aliens in the past 20 years. Unless ballast- and hull transport are strictly controlled, shipping-mediated introductions of alien species are set to increase. Climate change and biological invasions are key drivers affecting biodiversity, yet their impacts are rarely considered in tandem. As Erythrean aliens make their way northwards and westwards across the Mediterranean Sea, the most invasive of the lot attract attention for their realized or potential impacts on the native biota, or as health hazards. The result of the ongoing climate change is an increasing discrepancy between the requirements of native species and altered environmental conditions. In climate-facilitated invasions, the occurrence of alien species depends on change in the receiving environment that drives native species to become increasingly ill adapted to the local environment, whereas the aliens are better adapted to the new conditions. The Erythrean aliens are thermophilic species and it is likely that the rising sea-water temperature favour their colonization, reproduction, growth, persistence and spread, and provide them with a distinct advantage over native temperate Mediterranean taxa. Their presence alters population dynamics of native biota, the structure and composition of communities and functioning of ecosystems. However, no implicit or explicit management strategies has yet been discussed to curb the influx of Erythrean aliens that impact the already teetering fisheries, mariculture, and tourism through proliferation of alien parasitic, noxious and poisonous species, displacement of commercially- important native species. The changes in biodiversity patterns in the Mediterranean are linked to climate change and invasive species, as well as to the well-established drivers of habitat change, overexploitation and pollution, and pose complex challenges for the maintenance of biodiversity and ecosystem function. Thus far, we have failed to assess the cost of environmental damage, and ignored the depletion of resources, environmental degradation and health impacts caused by alien invasion. There is a need for better Mediterranean marine governance. The EU recently introduced the Marine Strategy Framework Directive (MSFD, EU Commission 2008), which aims at achieving good environmental status in European Waters. The peri-Mediterranean countries need to develop their own optimal marine management capacity to avoid irreversible negative outcomes. While researching, defining and agreeing on management strategies and governance by the diverse communities of scientists, stakeholders and policymakers have barely began, native and alien communities re-assemble and establish under a new climate regime in the Mediterranean Sea.

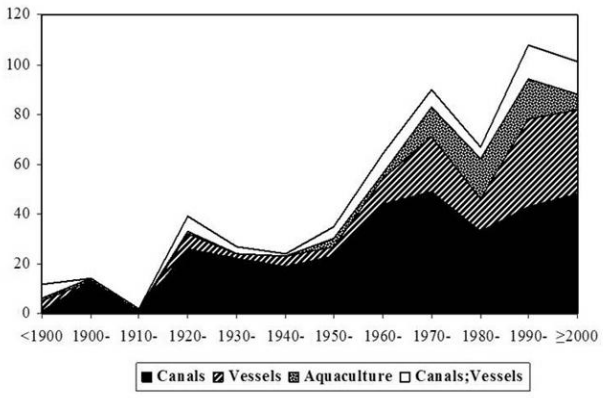


Fig. 1. Alien species recorded each decade in the Mediterranean and their vectors.

References

1 - Galil B.S., 2009. Taking stock: inventory of alien species in the Mediterranean Sea. *Biological Invasions*, 11: 359-372.

2 - 2 - Ozcan T., Galil B.S., Bakir K. and Katagan T., 2006. The first record of the banana prawn *Fenneropenaeus merguiensis* (De Man, 1888) (Crustacea: Decapoda: Penaeidae) from the Mediterranean Sea. *Aquatic Invasions*, 1: 286-288.

3 - 3 - Mineur F., Johnson M.P., Maggs C.A., Stegenga H., 2007. Hull fouling on commercial ships as a vector of macroalgal introduction. *Marine Biology*, 151: 1299-1307.

HIGHER TAXA SURROGATES OF MARINE BIVALVIA (MOLLUSCA) AND POLYCHAETA (ANNELIDA) DIVERSITY IN THE EASTERN MEDITERRANEAN (GREEK WATERS)

Maria-Lora Ganouli [1]*, Drosos Koutsoubas [2] and Chariton Charles Chintiroglou [3]
[1] Department of Marine Science, University of the Aegean, 81100, Mytilene, Greece - poushkas@yahoo.gr
[2] Department of Marine Science, University of the Aegean, 81100, Mytilene, Greece
[3] Department of Zoology, School of Biology, PO Box 134, Aristotle University of Thessaloniki, 541 24 Thessaloniki, Greece

Abstract
Higher-taxon richness as a surrogate for species was used to estimate the species richness of marine bivalvia and polychaeta in the Greek waters of the Eastern Mediterranean. In both these classes, significant and positive relationships between generic and species richness were found. Family richness is also strongly related to the number of species. This suggests that identification to the family level may be sufficient in many routine surveys. At the generic or family level, this surrogate method may be a valuable tool for locating and designing representative systems of protected areas for the well-documented zoobenthic communities that occur in Greek waters.
Keywords: Biodiversity, Bivalves, Polychaeta

Introduction
The assessment of biodiversity usually relies on a proxy, such as species richness or diversity [1]. However, the use of lower taxonomic resolution has also proved promising in environmental monitoring and impact studies [2-3]. A series of studies have demonstrated good congruence between species richness patterns and higher-taxon richness, indicating that this approach could be a promising tool in conservation biology for the rapid estimation of species richness [4-5]. In the present study 753 species of marine polychaeta and 308 bivalvia were considered and using regression techniques were tested for whether higher taxons are a good surrogate for species diversity.

Materials and Methods
According to the comprehensive checklist of Simboura and Nicolaidou (2001) [6], 753 benthic polychaete species have been recorded in Greek waters. Data 308 species of bivalvia [7] were used. The data were aggregated to higher taxonomic levels and correlations were made between species richness, genus and family richness. Four models (linear, polynomial of power 2, polynomial of power 3 and exponential) were fitted so as to be able to investigate the predictive power of higher order diversity on species richness. The best-fitting model was chosen on the basis of the highest correlation coefficient values. The univariate method applied was that of linear regression (Pearson and Spearman correlation coefficients). Correlations were used to relate the number of species to the number of genera and families in the two datasets.

Results and Discussion
All relationships between species, genus and family were significant for both taxa studied ($P < 0.001$) (Tab1).
These correlations show that it is possible to use higher taxa as a surrogate for species in surveys of richness. Cross taxon correlations of the richness at the different taxonomic levels were positive and strong (Tab 2). The analyses performed in the present study showed that generic and family levels could be used as a reasonable surrogate for species richness in eastern marine bivalvia and polychaeta. Surrogacy can be seen both as a preliminary approach, in cases when it is not possible to quickly identify all for conservation purposes, or as an end in itself, in regions where most species are unknown, or when insufficient resources are available to further pursue the identification process [8].

Tab. 1. Correlation coefficients for the regression between species, family and genera richness for the bivalvia and polychaeta fauna

	Linear	Polynomial of power 2	Polynomial of power 3	Exponential
Species vs. family				
Bivalvia	0.939	0.973	0.974	0.967
Polychaeta	0.877	0.950	0.998	0.978
Species vs. genera				
Bivalvia	0.961	0.970	0.9734	0.982
Polychaeta	0.965	0.966	0.977	0.992
All correlations are significant at p < 0.001 level				

Tab. 2. Cross taxon correlations (Pearson and Spearman coefficients) for different taxonomic levels

Polychaeta	Pearson			Spearman		
	Species	Genera	Families	Species	Genera	Families
Bivalvia						
Species	0.974	0.952	0.920	0.991	0.991	0.900
Genera	0.966	0.953	0.947	0.964	0.964	0.991
Families	0.929	0.906	0.913	0.891	0.891	0.954
All correlations are significant at a = 0.001 level						

References
1 - Magierowski R.H. and Johnson C.R., 2006. Robustness of surrogates of biodiversity in marine benthic communities. *Ecological Applications* 16(6): 2264-2275.
2 - Somerfield P.J. and Clarke K.R., 1995. Taxonomic levels, in marine community studies, revisited. *Marine Ecology Progress Series*, 127: 113-119.
3 - Olsgard F. and Somerfield P.J., 2000. Surrogates in marine benthic investigations – which taxonomic unit to target? *Journal of Aquatic Ecosystem Stress and Recovery*, 42: 25-42.
4 - Williams P.H. and Gaston K.J., 1994. Measuring more of biodiversity: can higher-taxon richness predict wholesale species richness? *Biological Conservation*, 67: 211-217.
5 - Hodge S. and Frampton C., 2001. Using higher taxa to estimate species richness: birds on New Zealand islands. *Ibis* ,143: 146-148.
6 - Simboura N. and Nicolaidou A., 2001. The Polychaetes (Annelida, Polychaeta) of Greece: checklist, distribution and ecological characteristics. *Monographs on Marine Sciences*, Series no 4. NCMR, pp 115.
7 - Zenetos A., 1996. The Marine Bivalvia (Mollusca) of Greece. FAUNA GRAECIAE: Volume VII. Hellenic Zoological Society & NCMR (ed), Athens, pp 319.
8 - Cardoso P., Silva I., de Oliveira N.G. and Serrano A.R.M., 2004. Higher taxa surrogates of spider (Araneae) diversity and their efficiency in conservation. *Biological Conservation*, 117: 453-459.

DIFFERENTIATING DAILY GROWTH STRATEGIES WITH STABLE ISOTOPE ANALYSIS FOR TROPHISM OF ALBORÁN SEA SARDINE LARVAE

Alberto Garcia [1], Jose M. Quintanilla [1], Raul Laiz-Carrion [1]* and Jesus Mercado [1]
[1] Instituto Español de Oceanografia - raul.laiz@ma.ieo.es

Abstract
A combined study of Alboran Sea sardine larval growth which differentiated two different growth strategies with stable isotope analysis for trophism yielded no trophic differences between both the two populations. The faster growing larvae showed higher C:N relationship in relation to the slower growing larvae.
Keywords: Larvae, Alboran Sea, Growth, Trophic Relations

Introduction
Sardine is a key species of the neritic ecosystem off the Alboran Sea coasts, constituting its major small pelagic resource. Its economic and ecological interest has been manifest through studies focusing on early life daily growth [1] and larval condition [2]. This study intends to provide new insights in larval growth variability with stable isotope analysis.

Material and Methods
A single catch of schooling post-flexion sardine larvae was sampled to study trophic influence on daily growth variability. The larval school was sampled at night time by means of a surface Bongo 90 tow off the nearshore coasts of Málaga. Larvae were sorted on board and stored in liquid nitrogen. Sampling and laboratory procedures are described in [3]. In the laboratory, larvae were thawed, measured for standard length (SL) and dry weighed (DW) after dry freezing during 24 hours. Otolith microstructure analysis allowed estimating the daily growth of larvae as described in [3] while natural abundance of ^{15}N ($\delta^{15}N$, %) and ^{13}C ($\delta^{13}C$, %) were measured using an isotope-ratio spectrometer (Thermo-Finnigan Delta-plus) coupled to an elemental analyser (FlashEA1112 Thermo-Finnigan). The determinations were calibrated against atmospheric nitrogen and PeeDee Belemite, respectively. using acetanilide as standard.

Results and Discussion
The sardine larval school comprised exclusively post-flexion larvae ranging from 12.2-19.0 mm standard length (SL). The SL vs DW relationship of the larval cohort differentiated two relative growth relationships originating from different growth strategies, that is, a normal growing population (N) in contrast with a slower growing larval population (S) investing growth energy in gaining somatic weight rather than length (Fig. 1). Their respective LnAGE vs LnSL and LnDW relationship is significantly different. LnSL and LnDW of the N growing population is greater than the S larvae (ANCOVA $F_{1, 176}$=142.8, p<0.001). $\delta^{15}N$ averaged 7.07‰ (± 0.50), indicating trophism within the phytoplankton size fraction around the 200mm threshold, while $\delta^{13}C$ averaged -17,9‰ (± 0.63). A previous study indicates that the values of $\delta^{15}N$ and $\delta^{13}C$ for the particulate organic matter fraction <200 mm, which is mainly phytoplankton in the study area during spring- is 3.71‰ (± 1.07) and 21.93‰ (± 0.58), respectively.

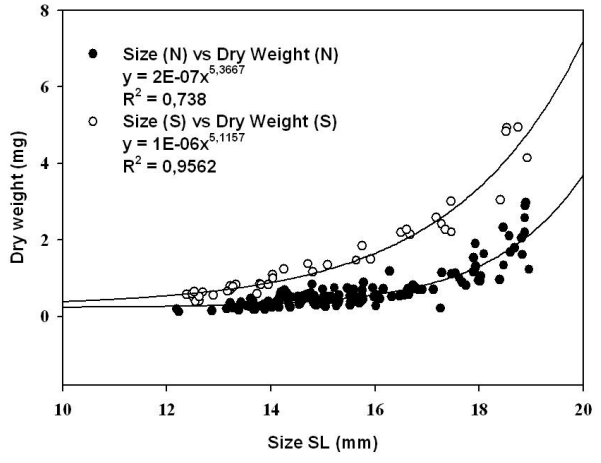


Fig. 1. Dry weight vs SL

The isotopic enrichment of the N from the particle pool <200 mm to sardine larvae was about 3.8‰. The relatively low nitrogen enrichment indicates that this plankton fraction constitutes the main diet of the sardine larvae. Nevertheless, the N and S populations did not show significant differences (ANOVA, p>0.05) in respect to $\delta^{15}N$ and $\delta^{13}C$, and therefore, no dietary difference. A greater gain in somatic mass with age in the S population is corroborated with a significantly greater Nitrogen percentage (N%) (ANCOVA $F_{1, 135}$=9.7, p<0.01), while the greater growth potential of the N population is in agreement with its significantly greater Carbon percentage (C%). The Fulton index, indicative of energy storage in individuals showed significant linear increase with age in both populations (r^2=0,72 and 0.92, respectively), whereby the S larvae showed significantly higher values than the N larvae (ANCOVA $F_{1, 176}$=461.1, p<0.001). Lastly, the C:N relationship showed a significant decrease with age/size of both populations (Fig. 2) similar to the growth rate decline with age/size. N larvae presented a greater C:N ratio than the S larvae (ANCOVA $F_{1, 135}$=63.6, p<0.001) demonstrating a greater investment of the N larvae in the structural development of larvae with time rather than energy reserve components.

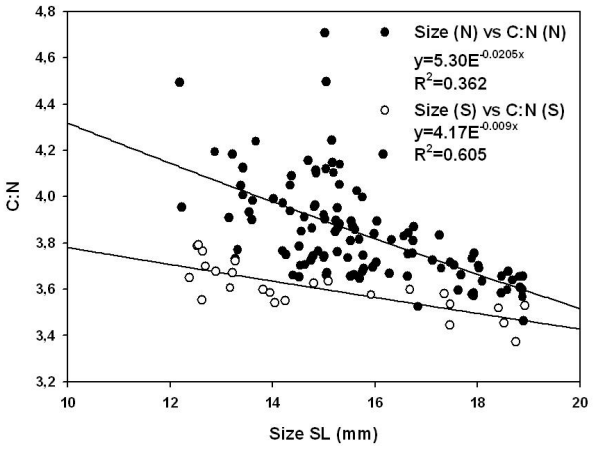


Fig. 2. C:N vs SL

References
1 - García A.., 2006. Estudio sobre la variabilidad del crecimiento larvario de la sardina (Sardina pilchardus, Walbaum) del Mar de Alboran. Ph. D. Thesis. Univ. of Vigo.
2 - Cortés, D., 2006. Estudio de la variabilidad del estado nutricional medido mediante indicadores bioquímicos de las larvas de sardina (Sardina pilchardus) del Mar de Alborán. Ph. D. Thesis. Univ. of Vigo.
3 - García, A., D. Cortés, T. Ramírez, A. Giráldez y A. Carpena., 2003. Contribution of larval growth rate variability to the recruitment of the Bay of Málaga anchovy (SW Mediterranean) during 2000-2001 spawning seasons. *Sci. Mar*. 67(4): 477-490.

INFLUENCE OF ABIOTIC FACTORS IN THE BIOMASS OF DEEP WATER SHRIMPS, *P. LONGIROSTRIS* AND *A. ANTENNATUS*, OFF CATALANO-LEVANTINE MEDITERRANEAN COAST OF SPAIN

Mariano Garcia Rodriguez [1]*, Angel Fernandez Gonzalez [1] and Antonio Esteban Acon [1]
[1] Instituto Español de Oceanografia - mariano.garcia@md.ieo.es

Abstract
Deep-water shrimps show large inter-annual fluctuations in biomass. We analysed the influence of some abiotic factors in these fluctuations using survey data (2006-2009). While *Parapenaeus longirostris* biomass was feebly affected by the T-S of the water masses, these factors, particulary salinity, seemed to have a significant effect on *Aristeus antennatus*, a species considered to be stenothermal and stenohaline, whose biomass distribution showed a direct relationship with the Levantine Intermediate Water.
Keywords: Biomass, Decapoda, Western Mediterranean

Introduction
The deep-water rose shrimp (*Parapenaeus longirostris*) and the red shrimp (*Aristeus antennatus*) are demersal species found on sandy and muddy bottoms in the Mediterranean Sea and South Atlantic Ocean of the Iberian Peninsula. Both species are among the most valuable resources for the trawl fishery. They show high inter-annual fluctuations in landings, despite the fishing effort applied remains almost constant, which suggests that these fluctuations do not completely dependent on fishing activities. Here we present an exploratory study of the influence of some abiotic factors in the biomass fluctuations of these two species.

Materials and Methods
Data are from the MEDITS_ES International spring trawl survey (2006-2009), performed according to a standard methodology [1]. Depth, temperature and salinity were recorded by means of a CTD SBE-37 probe located in the mouth of the gear. For each of these factors, the average of the data recorded during the effective trawl (when the gear is in contact with the bottom) was estimated for each haul and included in the analyses. Time period (2006-2009) and latitude were also considered as factors. Species biomass per haul was calculated as the catch in weight by sweep area and expressed in kg/km^2. G.I.S. was used to represent yearly distribution maps by kriging. Data were normalised by transforming to Ln (n+1), and the relationship between the different factors and species biomass was analysed by means of linear and multiple regressions (GLM), applying a simple model without interactions.

Results and Discussion
Analyses comprised data from 293 hauls (33-816 m depth) collected over a period of four years (2006-2009). Both salinity and temperature were highly correlated with depth, showing a gradient on both the continental shelf and the upper slope, with colder and saltier waters in depth, corresponding to the Modified Atlantic Water (MAW) and Levantine Intermediate Water (LIW) in the shelf and the slope, and to the Western Mediterranean Deep Water (WMDW) in depth, especially in the Ibiza channel. Average biomass of both species seemed to increase over the four years. Overall, *P. longirostris* was more abundant in Southern latitudes while *A. antennatus*' presence increased towards the North. *P. longirostris* appeared in 52 hauls comprising a depth range 370 m wide, with maximum biomass values in the 200-500 m depth interval. *A. antennatus* appeared in only 25 samples, showing a depth range 698 m wide, with maximum values in the 500-800 m interval. Despite both species biomass decreased with temperature and increased with salinity, we found remarkable differences between them in this sense. Thus, *P. longirostris* biomass appeared distributed in ranges of temperature and salinity 1.2442 C° and 0.5378 psu wide, respectively, with averages of 13.2010 C° (±0.2383 S.D.) for temperature and 38.5191 psu (±0.1505 S.D.) for salinity. On the other hand, despite its depth range was almost two-fold wider, *A. antennatus* showed a narrower range for temperature (0.3135 C°)and salinity (0.0859 psu), with 13.1569 C° (±0.099 S.D.) and 38.5054 psu (±0.0242 S.D.) as averages respectively. According to these observations, full model (all factors included) explained only 21% of the variance in *P. longirostris* biomass, none of the factors being significant for $\alpha = 0.05$. In the case of *A. antennatus*, full model explained 44% of the variance, with depth and salinity being significant factors. These results suggest that *P. longirostris* fluctuations may be due to factors different from T-S, such as recruitment strength, food availability or others. In contrast, *A. antennatus* biomass seems to be significantly affected by T-S of the water masses, specially salinity, which reinforces its stenothermal and stenohaline character [2] as well as its direct relationship with the LIW [2] [3].

References
1 - Relini G., carpenteri P., Murenu M. (eds)., 2008. Manuale di Instruzioni Medits. *Biol. Mars Mediterr*. 15 (suppl. 2): 1-78.
2 - García Rodríguez, M., 2005. La Gamba roja *Aristeus antennatus* (Risso, 1816) (Crustacea, Decapoda): distribución, Demografia, crecimiento, explotación y reproducción en el Golfo de Alicante, Canal de Ibiza y Golfo de Vera. Tesis Doctorales del Instituto Español de Oceanografía. N º 20. ISSN: 1578-410X.
3 - Guijarro B., E. Massutí, J. et P. Moranta Díaz., 2008. Dynamique des populations de la crevette rouge *Aristeus antennatus* dans les îles Baléares (Méditerranée occidentale): spatio-temporelle des différences et l'influence des facteurs environnementaux. *Journal of Marine Systems*, 71: 385-402.

MEDUSIVOROUS FISHES OF THE LIGURIAN SEA 2. THE SPECIALIST, *SCHEDOPHILUS MEDUSOPHAGUS* COCCO, 1839

Fulvio Garibaldi [1]*, Lidia Orsi Relini [1] and Giulio Relini [1]
[1] Università di Genova, DIP.TE.RIS., Centro di Biologia Marina del Mar Ligure - garibaldi.f@libero.it

Abstract
From 2004 onwards, several adult specimens of the cornish blackfish *Schedophilus medusophagus* were sampled in the Ligurian Sea: these fish represent first adult captures in the whole Mediterranean. The presence of the mauve stinger *Pelagia noctiluca* in the stomach contents of one specimen is described. The fish was eating a large number of entire jellyfish and showed in the caudal portion of the stomach a coloured concentrate of this food.
Keywords: Medusae, Fishes, Pelagic, Ligurian Sea

Schedophilus medusophagus was described by Cocco [1] in Sicily. The specific name was questioned by Günther [2] because "the fish could draw but little nourishment from jellyfish". Only one century later, the value of pelagic cnidarians as food for vertebrates was fully understood. Ates [3] was able to list 75 species of medusivorous fishes; 15 of them were reported to have their stomach filled solely, or for a considerable part, with jellyfish remains. Fish belonging to the family Centrolophidae are recognized as specialists in the association with jellyfish during their juvenile and young adult phases, so that the term "medusafish" was coined for them [4].
Four species are present in the Mediterranean: *Centrolophus niger* (Gmelin, 1789), *Hyperoglyphe perciformis* (Mitchill, 1818), *S. ovalis* (Cuvier, 1833) and *S. medusophagus* Cocco, 1839. The latter was recorded in Western Mediterranean [5] and Adriatic Sea [6; 7; 8], but it is still a poorly known species because most specimens collected to date are juveniles [4] and sometimes larvae. Past Mediterranean literature and iconography [9; 10], always relate to juveniles as well as the records, until the beginning of the millennium. In recent times, and especially from 2004 onwards, an important sampling of *S. medusophagus* was carried out in the Ligurian Sea. This abundance could be related to jellyfish (*Pelagia noctiluca*) blooms that occurred in the last few years in the Western Mediterranean. At the best of authors knowledge, a collection of many adult fish is unprecedented both in Mediterranean and in the adjacent Atlantic.



Fig. 1. The adult female *Schedophilus medusophagus* caught off Sanremo on 28th June 2006

One of these specimens, a female, 64 cm TL, caught off Sanremo on 28th June 2006 (Fig. 1), gave the opportunity to observe the stomach content consisting solely of *P. noctiluca*, for a total volume of 400cc (Fig. 2).
The cephalic portion of the stomach showed several complete individuals of *P. noctiluca* (umbrellas plus manubrium with oral arms). An ink-like liquid completely filled the caudal part of the stomach, showing evidences that, during the digestion, the pigments of *P. noctiluca* are transformed into a violet fluid that colours the entire gut.

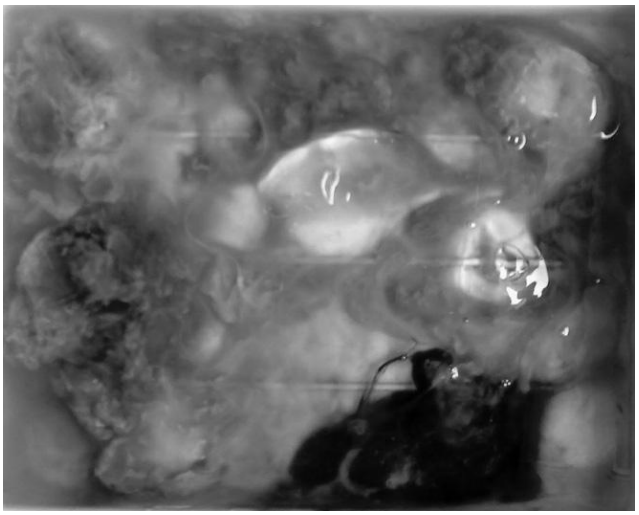


Fig. 2. Stomach content of the adult *S. medusophagus* from the Ligurian Sea, showing entire undigested *P. noctiluca* specimens and product of digestion (black spot at the bottom of the picture)

References
1 - Cocco A., 1839. Sopra un nuovo genere di pesci della famiglia dei Centrolofini e di una nuova specie di *Trachurus*. *L'Innominato*, Messina, 3, 56-59.
2 - Günther A., 1882. Description of a specimen of *Schedophilus medusophagus*, a fish new to the British fauna. *Trans. Zool. Soc. London*, 11: 223-224.
3 - Ates R.M.L., 1988. Medusivorous fishes, a review. *Zool. Meded*., 62: 29-42.
4 - Haedrich R.L., 2002. Centrolophidae. Medusafishes (ruffs, barrelfish). p. 1867-1868. In: K.E. Carpenter (ed.) FAO species identification guide for fishery purposes. The living marine resources of the Western Central Atlantic. Vol. 3: Bony fishes part 2 (Opistognathidae to Molidae), sea turtles and marine mammals.
5 - Haedrich R.L., 1986. Family: Centrolophidae and Nomeidae. In: Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J., Tortonese E.(eds.), 1984-86. Fishes of the north-eastern Atlantic and Mediterranean. UNESCO, Paris.
6 - Ninni E., 1912. Catalogo dei pesci del Mare Adriatico. Venezia.
7 - Onofri, L. 1986. The rare saw-cheeked fish (*Schedophilus medusophagus* Cocco, 1839) (Pisces: Centrolophidae in the central Adriatic. *Zbornik Matice Srpske za prirodne Nauke/ Proc. Nat. Sci., Matica Srpska*, 70: 135-141.
8 - Dulcic, J., 1998. First record of the cornish blackfish *Schedophilus medusophagus* (Pisces: Centrolophidae) larvae from the Adriatic Sea. *J. mar. biol. Ass. U.K.*, 78: 1035-1038.
9 - Bini G., 1968. Atlante dei pesci delle coste italiane. Mondo Sommerso ed. Print offset, Roma, vol. 6: 177 pp.
10 - Tortonese E., 1975. Fauna d'Italia. Osteichthyes (Pesci Ossei), Calderini, Bologna, Vol. 11: 636 pp.

ON THE REPRODUCTION OF *ACANTHEPHYRA EXIMIA* S. I. SMITH, 1884 IN THE CENTRAL WESTERN MEDITERRANEAN

Alice Gastoni [1]*, Ivan Locci [1], Antonello Mulas [1] and Maria cristina Follesa [1]
[1] Department of Animal Biology and Ecology – University of Cagliari - gastoni@unica.it

Abstract
Macroscopic and histological analysis were performed on the female gonads of *Acanthephyra eximia*. The macroscopic observation regarding the changes of the ovaries leads us to identify six stages of development, validated by histological analysis.
Keywords: Decapoda, Western Mediterranean, Reproduction

Introduction
Acanthephyra eximia S. I. Smith, 1884 is a cosmopolitan nektobenthic species, common in waters below 1000 m [1, 2], where it represents the most abundant decapod of the lower-slope communities [3]. Nevertheless, the current knowledge on its biology, especially on the reproductive cycle, is scanty. Aim of this work is to provide some information concerning the reproductive pattern of this species.

Materials and Methods
Samples of *A. eximia* were collected from experimental trawl surveys carried out between 580 and 1598 m in the Sardinian waters from 2003 to 2009. Carapace length (CL, in mm), total and ovarian weight (TW, OW in grams) for each specimen were registered. The determination of stage's development maturity was performed using macroscopic descriptions validated by histological examinations. Preparation of ovarian tissues for microscopic analysis, performed following Dominici's method [4], included fixation, sectioning, oven drying and staining.

Results and Discussion
We analysed 478 females of *A. eximia*, the carapace length ranged from 8.2 to 38.0 mm CL, with a mean ± SD of about 27.0 ± 4.6. The range size of females carrying eggs was 22.1 - 35.4 mm CL. The smallest and the biggest spermatophores-bearing specimens measured 25.8 and 35.4 mm CL respectively. During the analysis, six developmental stages changing shape, dimension and colour, were identified (Tab.1).

Tab. 1. Developmental stages scale proposed for *Acanthephyra eximia* caught in the Sardinian sea

Stage	Macroscopical description
I, Immature	Ovaries thin and whitish. Eggs not visible
II, Developing	Ovaries yellow in colour, growing. Eggs start to be visible
IIIa, Maturing	Ovaries turgid and pale-orange in colour. Eggs achieving greater dimensions
IIIb, Pre-spawning	Ovaries bright-orange in colour and swollen in the cephalotoracic region
IV, Spawning	Ovaries vivid red in colour. Eggs ready for spawning
V, Post-spawning	Ovaries flaccid, thin and trasparent
Stage	**Hystological description**
I, Immature	Oogonia and primary oocytes in the germinative zone. Follicular cells appear
II, Developing	Lipidic vesicles oocytes appear, primary vitellogenesis starts (oocytes Y1)
IIIa, Maturing	Secondary vitellogenesis starts (oocytes Y2). Follicular cells flatten
IIIb, Pre-spawning	Tertiary vitellogenesis starts (oocytes Y3). Nucleus disappearing
IV, Spawning	Ovary entirely filled with oocytes. Nucleus disappears
V, Post-spawning	Empty follicles and atresic oocytes undergoing phagocytosis

In the present study, a complete macroscopic and histological description of the various maturity stages has been performed. During monthly samplings, carried out throughout the year (except in April, October and December), we observed a regular occurrence of females with different developmental ovarian stages. In particular mature females (stage IV) were found in March and September (28 out of 290 and 1 out of 65, respectively) (Fig. 1).

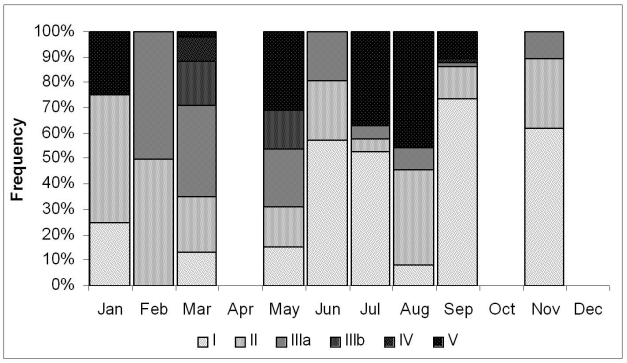


Fig. 1. Annual trend in percentage occurrence of different maturity stages of females of *Acanthephyra eximia* caught in the Sardinian sea

Eggs are carried in a big clutch among the pleopods, their colour matches with the pleon, likely a sort of camouflage, as observed for other middle-slope decapod crustaceans [5].

References
1 - Morales-Nin B., Maynou F., Sardà F., Cartès J.E., Moranta J., Massuti E., Company J., Rotllant G., Bozzano A., Stefanescu C. and Lirò C., 2001. Size influence in zonation patterns in fishes and crustaceans from deep-water communities of the western Mediterranean. *NAFO SCR Doc. 01/142.*
2 - Koukouras, A., 2000. The pelagic shrimps (Decapoda Natantia) of the Aegean Sea with an account of the Mediterranean species. *Crustaceana*, 73: 801–814.
3 - Cartes J.E., 1991. Analisis de las comunidades y estructura trofica de los crustaceos decapodos batiales del Mar Catalan. *Tesis Doctoral, Universitat Politecnica de Catalunya.*
4 - Mazzi V., 1977. Tecniche istologche e istochimiche. Eds. Piccin, pp 750.
5 - Cabiddu S., Follesa M.C., Gastoni A., Porcu C. and Cau A., 2008. Gonad development of the deep-sea lobster *Polycheles typhlops* (Decapoda: Polychelidae) from the central western Mediterranean. *J. Crust. Biol.*, 28(3): 494-501.

ETUDE DE LA COMPOSITION BIOCHIMIQUE DES ORGANES OSMOREGULATEURS DE L'ANGUILLE EUROPEENNE *ANGUILLA ANGUILLA* ACCLIMATEE EN EAU DOUCE ET EN EAU DE MER

N. Ghazali [1]*, D. Boussoufa [1], I. Rabeh [1], K. Telahigue [1], I. Chetoui [1], J. C. Navarro [2] and M. El Cafsi [1]
[1] Unité de Physiologie et d'Ecophysiologie des Organismes Aquatiques, Faculté des Sciences de Tunis, 2092, Tunisia - ghazalinabila@yahoo.fr
[2] Instituto de Acuicultura de Torre de la Sal (CSIC), 12595 Ribera de Cabanes, Spain

Abstract
Le suivi des réserves énergétiques de l'anguille européenne, acclimatée en eau douce et en eau de mer pendant un mois, au niveau des organes osmorégulateurs (branchies, œsophage, intestin et rein) montre que ce poisson utilise, probablement, le glycogène comme principale source énergétique.
Keywords: Fishes, Physiology, Salinity

Introduction
L'anguille européenne est une espèce très euryhaline. Comme tout poisson qui s'adapte aux différentes salinités du milieu, son osmorégulation suggère une variation dans sa demande énergétique. L'objectif de ce travail est d'étudier les réserves énergétiques (glycogène, lipides et protéines) au niveau des organes osmorégulateurs (branchies, œsophage, intestin et rein) chez l'anguille jaune *Anguilla anguilla* acclimatée en eau douce et en eau de mer.

Matériel et méthodes
L'anguille européenne est pêchée dans le lac de Tunis dont la salinité est de 21 ‰. Deux lots d'anguilles jaunes (*c.à.d* immatures) ont été acclimatés à deux salinités différentes : 0,5 ‰ et 35 ‰. Au bout de quatre semaines, une série de 8 individus sont sacrifiés de chaque lot et pour chaque analyse biochimique. Après anesthésie, les poissons sont disséqués et les organes osmorégulateurs : branchies, œsophage, intestin et rein sont conservés à -30°C pour être analysés. Les protéines sont dosées selon la méthode de Lowry [1]. Le glycogène est isolé, hydrolysé puis dosé sous forme de glucose par une méthode enzymatique en présence de glucose oxydase. Les lipides totaux sont quantifiés après extraction [2].
Les résultats sont analysés statistiquement par ANOVA en appliquant le test de Tukey. La différence statistique est considérée significative à $p<0,05$ (*) et hautement significative à $p < 0,01$(**).

Résultats et discussion
Le tableau 1 montre la variation de la teneur en protéines, en glycogène et en lipides totaux au niveau des organes osmorégulateurs de l'anguille acclimatée en eau douce et en eau de mer. Les branchies sont probablement le principal organe osmorégulateur puisqu'elles sont en contact direct avec le milieu extérieur. La comparaison de la composition biochimique de cet organe en eau douce et en eau de mer montre qu'il y a une différence significative ($p=0,0002$) de la teneur en glycogène qui est plus importante en eau de mer. Il n'y a pas de différence significative de la teneur en protéines ni en lipides dans cette comparaison.
Le suivi des réserves énergétiques au niveau de l'œsophage de l'anguille jaune montre que le taux de glycogène est significativement plus élevé ($p=0,0002$) chez les poissons d'eau douce par rapport à ceux acclimatés en eau de mer. On peut déduire qu'il y a eu probablement consommation de cette réserve dans le milieu hyperhalin.
Pour l'intestin et en eau douce, nous remarquons une diminution significative de la teneur en protéines et de la teneur en glycogène.
Au niveau du rein, nos résultats ne montrent aucune différence significative pour les réserves énergétiques de l'anguille jaune acclimatée en eau douce et en eau de mer.
En conclusion nous pouvons déduire que, probablement, au niveau de ces organes osmorégulateurs, l'anguille, poisson particulier, utilise principalement le glycogène comme source énergétique, bien que chez d'autres poissons, en l'absence de glucides alimentaires, ce sont les protéines et les lipides qui sont rapidement et efficacement métabolisés afin de fournir l'énergie nécessaire à la couverture des besoins de l'organisme [3].

Tab. 1. Variation de la teneur en protéines (mg/g M.F), en glycogène (mg/g M.F), en lipides totaux (mg/100mg M.F) au niveau des organes osmorégulateurs de l'anguille acclimatée en eau douce et en eau de mer. Les résultats sont exprimés en moyennes ± Ecartype M.F : matière fraîche

		eau de mer	eau douce
Protéines	Branchies	74,6±3,30	68,33±7,04
	Oesophage	95,40±8,50	100,67±32,03
	Intestin	82,07±9,02	111,73±24,81*
	Rein	140,60±11,38	130,07±12,15
Glycogène	Branchies	0,87±0,05	0,60±0,06 **
	Oesophage	1,08±0,05	1,80±0,09 **
	Intestin	0,64±0,06	1,68±0,09 **
	Rein	0,97±0,06	1,00±0,07
Lipides totaux	Branchies	5,62±0,16	5,65±0,27
	Oesophage	4,10±0,90	3,43±0,48
	Intestin	5,18±0,48	4,81±0,38
	Rein	4,87±0,29	4,68±0,1

References
1 - Lowry, O.H., Rosebrough N.J., Farr A.L. and Randall R.J., 1951. Protein measurement with the Folin-Phenol reagents. *J. Biol. Chem.* 193: 265-275.
2 - Folch J., Lees M. and Sloane Stanley G.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem.*, 266 : 497–509.
3 - Cowey C., Walton M., 1989. Intermediary metabolism. In: Cowey C. & Walton *M*. (eds), Intermediary. Metabolism. Academic Press, pp 259-329.

ALIEN MOLLUSCS AND CRUSTACEAN DECAPODS IN THE STRAITS OF MESSINA (CENTRAL MEDITERRANEAN SEA)

S. Giacobbe [1], F. Dedomenico [1], S. P. M. Iarrera [2]*, M. C. Mangano [1], E. Porporato [1] and N. Spanò [1]
[1] Università degli Studi di Messina, Dip.to di Biologia Animale ed Ecologia Marina
[2] Università degli Studi di Messina, Dip.to di Costruzioni e Tecnologie Avanzate - samuela.iarrera9@gmail.com

Abstract
Alien benthic species in the Straits of Messina have been monitored since 2001 and consequently reviewed. Established molluscs and crustacean decapods accounted for nine and two species respectively, all of Indo-Pacific origin, except for one decapod that has spread from the Atlantic region. The records of five mollusc and two decapod species were considered as "casual".
Keywords: Biodiversity, Biogeography, Species Introduction, Strait Of Messina

Introduction
The effects of global warming and/or anthropogenic pressure on bioinvasion processes are emphasized in the Mediterranean, as a regional, highly anthropized sea which joins the Atlantic and Indo-Pacific regions [1]. Within the Mediterranean Sea, the Straits of Messina connects the western and eastern basins, thus representing a crossing node of migratory routes and human activities, favouring the spread of introduced species. In this paper original data on the occurrence of benthic alien species in the Strait is reported and examined in relation to their establishment.

Materials and methods
In order to detect the presence of alien species, quantitative samplings and specimen collections have been carried out in coastal (0-50m) and transitional waters (Capo Peloro lakes, Saline Ioniche harbour and salts) since April 2001 [2].

Result and Discussion
According to Zenetos *et al.*'s [3] criteria, 9 mollusc and 2 decapod established species have been identified: the lessepsian *Brachidontes pharaonis* (Fisher P., 1870), known in this area since 1974 [4]; *Bursatella leachi* De Blainvile, 1817 and *Melibe fimbriata* Alder & Hancock, 1864, both common locally since 2000; *Pinctada radiata* (Leach, 1814), sporadically recorded during 2000-2001 and regularly found since 2007; *Aplysia dactylomela* Rang, 1828, since 2008; *Cerithium scabridum* Philippi, 1848, since 2007, in all transitional waters; the Indo-Pacific *Crassostrea gigas* (Thunberg, 1793) and *Ruditapes philippinarum* (Adams & Reeve, 1850), that have been imported from the northern Adriatic to aquaculture farming since 1970 and 1980 respectively, together with *Anadara demiri* (Piani1981) (first recorded in 2007); *Marsupenaeus japonicus* (Bate, 1888), that arrived by natural dispersal; the Atlantic *Percnon gibbesi* (H. Milne Edwards, 1853), the only species which showed an invasive behaviour in the Strait, found since 2006. The arrival of other 5 "casual" species was related to the mussel and oyster trade. One specimen of the Indo-Pacific *Rapana venosa* (Valenciennes, 1846) was recorded in the Peloro coastal lakes in September 2008; the other species, although reported since 1982 [5], has never colonized this area, despite their regular introduction together with stalling shellfish; these species are the Indo-Pacific *Anadara inaequivalvis* (Bruguière, 1789),and the Atlantic *Littorina littorea* (L., 1758), *Crepidula fornicata*, (L., 1758) and *Nucella lapillus* (L., 1758). Finally, the occasional occurrence of the lessepsian *Portunus pelagicus* (L., 1758) and of the Atlantic *P. hastatus* (L., 1767)in coastal waters has been noted.

Conclusion
A prevalent Indo-Pacific origin, compared to the warm-temperate Atlantic one, connotes the established alien species in the Straits of Messina, whilst no western European species has thrived to date. Mollusc farming determined a remarkable colonization of transitional waters, whilst the coastal environment was colonised by introduced species which spread their Mediterranean areal northwards.

References
1 - Occhipinti-Ambrogi A. and Galil B.S.,2004. A proposal for uniform terminology on bioinvasions for mediterranean marine scientists. *Rapp. Comm. Int. Mer Médit.*, 37: 414.
2 - Profeta A., Bonanno A., Giacobbe S., Manganaro A., Potoschi A. Jr., Spanò N. and Triscari C., 2004. Diffusione di macrofite alloctone nello Stretto di Messina: il caso di *Caulerpa taxifolia* (Vahl) C. Agardh, *Caulerpa racemosa* (Forsskål) J. Agardh, *Halophila stipulacea* (Forsskål) Ascherson. *Biol. Mar. Medit.*, 11 (2): 465-467.
3 - Zenetos A., Çinar M.E., Pancucci-Papadopoulou M.A., Harmelin J.G., Furnari G., Anadaloro F., Bellou N., Streftaris N. and Zibrowius H., 2005. Annotated list of marine alien species in the Mediterranean with records of the worst invasive species. *Medit. Mar. Sci.*, 6/2: 63–118.
4 - Berdar A., Guglielmo L., Giacobbe S., 1975. Malacofauna bentonica e pelagica spiaggiata nello Stretto di Messina. *Boll. Pesca Piscic. Idrobiol.*, 30 (2):323-337.
5 - Di Natale A., 1982. Extra-Mediterranean species of Mollusca along the southern Italian coasts. *Malacologia*, 22 (1-2): 571-580.

DESIGNING A NETWORK OF MARINE RESERVES SUBJECTED TO DIFFERENT HUMAN CONSTRAINTS: THE CYCLADES ARCHIPELAGO CASE STUDY

Sylvaine Giakoumi [1]*, Hedley Grantham [2], Giorgos D. Kokkoris [1] and Hugh P. Possingham [2]
[1] University of the Aegean, Department of Marine Sciences, 81100 Mytilene, Lesvos island, Greece - sylvaine@marine.aegean.gr
[2] University of Queensland, The Ecology Centre, St. Lucia, Queensland 4072, Australia

Abstract
Best practice dictates that the design of networks of marine reserves follows the principles of systematic conservation planning which includes information about cost of making a reserve. Our study, which has taken place in the Cyclades archipelago (Greece), aims at detecting the sensitivity of reserve network configuration with respect to different ways of calculating cost. We discovered that the choice of priority areas for protection is greatly influenced by the cost definition and components.
Keywords: Cyclades Islands, Eastern Mediterranean, Marine Parks, Coastal Waters

Worldwide, marine reserves have been increasingly used as management and conservation tools for the protection of marine ecosystems from rapid and radical degradation. Marine reserves cover only the 0.01% of the total surface of the Mediterranean Sea [1]. At the same time, most marine protected areas in the region have been established in an *ad hoc* way with little or no scientific information [2]. Systematic conservation planning provides an efficient and transparent approach, guiding the location, configuration and management of conservation areas [3]. A crucial element of this procedure is the integration of socioeconomic costs [4].

Our study area covers the coastal area of 26 Kyklades islands in the Central Aegean Sea, North – Eastern Mediterranean Sea. Our conservation objectives are to protect: a) enough critical habitats for endangered and vulnerable species b) places with higher fish biomass to replenish adjacent areas. To identify priority areas for conservation we used the latest version of Marxan [5]. This software aims at achieving explicitly a set of conservation targets while minimizing the cost and the boundary length of the reserve system. Our aim was to create a reserve system from amongst 223 planning units. Each contains a stretch of the coastline and extents 1 km into the sea. We set high targets (50%) for priority habitats and species *(Posidonia oceanica*, *Cystoseira* spp., breeding caves for the Mediterranean monk seal *Monachus monachus*) and lower targets for other conservation features (abundance of 60 fish species and other habitat types). We produced 3 different scenarios considering different cost aspects: 1. fishing pressure, 2. fishing pressure and exposure to prevailing winds, 3. fishing pressure and exposure to winds reduced by expected benefits from tourism.

As we expected, the priority areas, which should be included in a network of marine reserves, vary according to different ways of including cost in the analysis (fig.1 & 2). In this study, we incorporate, for the first time in the relevant literature, the level of physical exposure to the cost of our planning units. We consider that planning units with high levels of wind and wave exposure have less opportunity cost regarding competitive uses of the coastal area (coastal fisheries, tourism).The results of our study are consistent with the current literature; all available information that affects the distribution of economic activities in a region should be included in marine conservation planning.

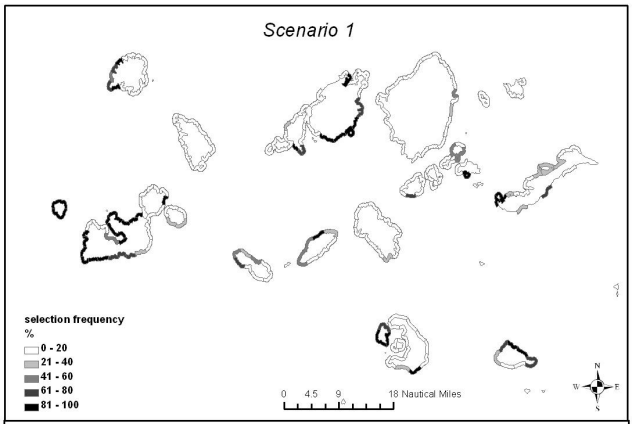


Fig. 1. Priority areas (darker colours) under cost scenario 1: fishing pressure

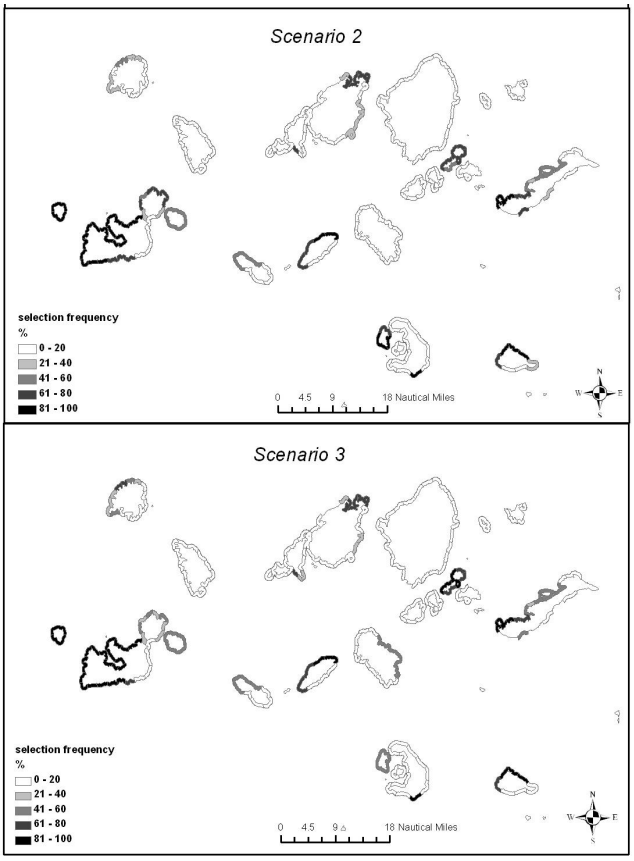


Fig. 2. Priority areas for cost scenario 2: fishing pressure and wind exposure and scenario 3: same as second scenario but reduced by tourism benefits

References
1 - Abdulla A., Gomei M., Maison E., and Piante C., 2008. Status of Marine Protected Areas in the Mediterranean Sea. IUCN, Malaga and WWF, France. 152 pp.
2 - Guidetti P., Milazzo M., Bussotti S., Molinari A. and others., 2008. Italian marine reserve effectiveness: Does enforcement matter? *Biol. Conserv*. 141:699–709.
3 - Margules C. R. and Pressey R. L., 2000. Systematic conservation planning. *Nature*, 405: 243–253.
4 - Sala E., Aburto – Opereza O., Paredes G., Parra I., Barrera J. C. and Dayton P. K., 2002. A general model for designing networks of marine reserves. *Science*, 298: 1991 – 1993.
5 - Ball I.R. and Possingham H., 2000. Marxan (V1.8.2): marine reserve design using spatially explicit annealing, a manual.

OCCURRENCE OF *OCYTHOE TUBERCULATA* (CEPHALOPODA: OCYTHOIDAE) IN THE STRAIT OF MESSINA (CENTRAL MEDITERRANEAN)

D. Giordano [1], B. Busalacchi [1]*, M. Liguori [2], F. Perdichizzi [1], E. De Domenico [2] and A. Profeta [1]
[1] Institute of Coastal Marine Environment IAMC-CNR - barbara.busalacchi@iamc.cnr.it
[2] Department of Animal Biology and Marine Ecology, University of Messina

Abstract

The occurrence of two females of *Ocythoe tuberculata* Rafinesque, 1814, during June 2006 and April 2009, in the Strait of Messina (Central Mediterranean) is reported. *O. tuberculata* is a pelagic octopod species rarely reported in the Mediterranean Sea.
Keywords: Cephalopods, Strait Of Messina

O. tuberculata is known to be cosmopolitan in tropical and temperate seas ([1], [2]).It was reported along the Mediterranean ([3],[4]), in the Greek waters [5], in the Catalanas coasts [6], and in the Sicilian Channel [7]. It has been reported off the Azores and Canary archipelagos and in Peruvian waters [8], in the west of Portugal and north-west of Spain [9]. Few informations are available about the biology and behaviour of this species. It shows a strong sexual dimorphism with males that are usually smaller than 3 cm in mantle length while females are larger with a maximum mantle length reported of 3,5 cm [10]. Females of *Ocythoe* are one of the few known cephalopods with a true swimbladder and the only known cephalopods that are ovoviviparous.

An interesting feature of the species is the mode of locomotion that occurs through the enormous funnel, considered one of the greatest of cephalopods, and the powerful cloak which provide great strength in the expulsion of water from the palleale cavity. The two specimens were caught at few metres by the falcate zone of S. Raineri (Strait of Messina): one of the two specimens was caught inside a group of Salps. The main morphological data of the two specimens are recorded and reported. The female caught in June 2006 was sexually mature, with a total length of 410 mm, total weight of 320 g, mantle length of 225 mm, mantle perimeter of 240 mm, mantle wide of 100 mm, eye diameter of 18 mm and funnel length of 44 mm. The female caught in April 2009 were a juvenile with a weight of 82,4 g, total length of 231 mm, mantle length of 84 mm, mantle perimeter of 148 mm, mantle wide of 55 mm, eye diameter of 17mm and funnel length of 35 mm. The presence of *O. tubercolata* in the Straits of Messina is probably in relation to the hydrodynamics phenomena of the Straits. The main characteristics of the Messina Straits are the strongest tidal currents reaching 300 cm/s or more, with the addition of other effects (wind for example). Strong turbulence is present mainly nearby the northern mouth, but in the whole Straits the currents are turbulent, with large internal waves. In fact other pelagic cephalopods as *Thysanoteuthys rhombus* were caught in the same area.



Fig. 1. Female of *O. tuberculata* caught in April 2009

Tab. 1. Morphological data of two females of *O. tuberculata*

	Female 1	Female 2
Date of capture	12/06/2006	29/04/2009
Weight (g)	320	82.4
Total length (mm)	410	231
Mantle length (mm)	225	84
Head length (mm)	35	20
Mantle perimeter (mm)	240	148
Mantle wide (mm)	100	55
Eye diameter (mm)	18	17
Funnel length (mm)	44	35

References

1 - Sweeney M.J., Roper C.F.E., Mangold K.M., Clarke M.R. and Boletzky S., 1992. "Larval" and juvenile cephalopods: a manual for their identification, vol. 510. *Smithsonian Contributions to Zoology*, 232 pp.

2 - Vecchione M., 2002. Cephalopods. In The living marine resources of the Western Central Atlantic, Vol. 1(K.E. Carpenter, Ed.). FAO: Rome.

3 - Petrus J.L. and de Pablo F., 1993. Nota sobre la captura d' *Ocythoe tuberculata* Rafinesque, 1814 (Cephalopoda: Ocythoidae) en aigues de Menorca. *Bolleti de la Societat d'Historia Natural de les Balears*, 36, 62-63.

4 - Ezzeddine-Najai S. and Al Abed A., 2001. Sur una espèce nouvelle dans la faune teuthologique de Tunisie: *Ocythoe tuberculata* Rafinesque,1914 (Cephalopoda, octopoda).www.instm.rnrt./dwl/pub8_2001.pdf.

5 - Corsini M. And Lefkaditou E., 1995. Occurrence of *Ocythoe tuberculata* (Cephalopoda : Ocythoidae) in Greek waters. *Boll. Malacol*., 30 (10-12): 304-310.

6 - Sanchez P., 1980. Nueva cita de *Ocythoe tuberculata* (Raf., 1814) (Cephalopoda: Ocythoidae) en las costas catalanas. *Invest. Pesq.*, Barcelona, 44 (1): 111-117.

7 - Jereb P. and Ragonese S., 1988. Sui cefalopodi di scarso o nullo interesse commerciale nel Canale di Sicilia. *Oebalia*, 16 (2): 689-692.

8 - Cardoso F., 1991. First record of net collected *Ocythoe tuberculata* (Cephalopoda: Octopoda) from Peruvian waters. *American Malacological Bulletin*, 8, 143-144.

9 - Caballero-Alfonso A.M., Ganzedo-López U., Díez-Díez G. and Castro J.J., 2008. New record of *Ocythoe tuberculata* (Cephalopoda: Ocythoidae) in the North-east Atlantic related to sea warming. *JBMA2- Biodiversity Records*. Published on line.

10 - Cardoso F. and Paredes C., 1998. La familia Ocythoidae (Cephalopoda: Octopoda) en el Perù. *Revista Peruana de Biologia*., 5, 7 pp.

RE-APPEARANCE OF *CAULERPA SCALPELLIFORMIS* (R. BROWN EX TURNER) C.AG. WEBER VAN BOSSE (CAULERPACEAE, CAULERPALES) IN THE GULF OF ANTALYA, TURKEY

Mehmet Gökoglu [1]*, Beylem Banbul Acar [1] and Halil Çolak [1]
[1] Akdeniz University, Faculty of Fisheries - gokoglu@akdeniz.edu.tr

Abstract
Caulerpa scalpelliformis is an alien species for Turkish coastline. Its first record was reported in 1995 from the Gulf of Antalya. At that time it was not considered as a serious thread for Antalya coastlines due to its disappearance from observed areas. However, it's more distribution and re-appearance in the same area was observed in summer 2009. The present study provides new and more data related to *Caulerpa scalpelliformis* invasion in the Gulf of Antalya-Turkey in 2009.
Keywords: Alien species, Eastern Mediterranean, Phytobenthos

Introduction
The first record of *Caulerpa scalpelliformis* (Brown ex Turner) C. Agardh 1817 from Turkey coastline was reported from Antalya Marina in summer 1995 [1]. Subsequently, presence of this species at the same area was investigated by Aysel et.al. (2002). In that study, it was also found locally out of the Marina [2]. *C. scalpelliformis* is orginated from tropical waters of Syria, Israel, Lebanon, Palestine and Egypt in the Mediterranean [3]. Its indo-Pacific distribution [4][5] in the Indian Ocean are reported in Aldabra Islands, Australia, India, Kenya, Madagascar, Mauritius, Mozambique, Oman, Pakistan, South-Africa, Sri Lanka, Tanzania and Yemen [2]. Local announcement of *C. scalpelliformis* from out of the Antalya Marina supports the belief that this species is transported by means of the ships or their hoes. This green algae species has only been reported from the coasts of Turkey, however there is no study except two papers. Therefore, event of *C. scalpelliformis* is not known until yet. The purposes of this study is to detemine distribution of *C. scalpelliformis* and its ecological parameters.

Materials and Methods
Distribution of *Caulerpa scalpelliformis* in the Gulf of Antalya was investigated by SCUBA dives. Two SCUBA equipments were used for dives. Depth and temperature of the water were measured using the underwater computer (Suunto Stinger). Skimmer net with 5 mm mesh size was used to collect the samples; SONY Cyber-Shot 40 m/132 ft marine pack housing and SONY DSC-T9 6.0 mega pixels camera were used to record the underwater movies and pictures. Many dives were conducted between the depths 0-40 m from Side (36º46'22."N,31º23'21."E) to Çirali (31º24'56."N,30º29'08."E) in the Gulf of Antalya.

Results
Caulerpa scalpelliformis was found exclusively in the areas between Antalya Marina (36°53'01"N, 30°42'02"E) and Antalya Great Harbour (36°50'16"N, 30°37'05"E). Species has covering and spreadable characteristics. The lowest water depth recorded for the species was 15 m outside the Yacht Harbour. Distribution of the species in the other area (Konyaalti beachs) ranged from 15 to 30 m depth. Species was not found on rocky bottoms. It was determined that *C. scalpelliformis* was available on the gravelly, sandy, slimy and gravelly-sludgy bottoms. However it was abundant on gravelly-sludgy and silty compact bottoms and frequently found at 2-10 m intervals. It has been also determined that stolons were aggregated in the area of 1-10 m^2, but the encounter frequency of *C. scalpelliformis* was decreased to 20-50 m on the sandy bottoms (Antalya Great Harbour). Aggregation on the sandy bottoms occurs with accumulation of a few stolons in 1-2 m^2. Species on sandy bottoms has poor vegetation and underdeveloped fronds. The peak vegetation was observed in the period of May-June. Deaths of the stolones of *C. scalpelliformis* were observed in July with increase in water temperature (26.5-27°C). In August at 28-30°C, the species completely died in certain areas while disappearance of 50% of stolons was observed at some areas. Distribution of the species was maximum at a depth of 20-22 m. Abundance of *Udotea petiolata* at the same depth is remarkable.

Discussion
The first record for *Caulerpa scalpelliformis* from the coasts of Turkey has been reported by Ertan et al. (1998). In that study this species has been found in the entrance of Antalya Marina. Ertan et al. (1998) collected the samples from though substrate at 0.5-2m between August and September at the same area in the period which water temperature declined and reported disappearance of the species. Reduction of water temperature has been shown as a possible reason of this situation and it was considered that the species was temporarily detected [1]. Similar results have been reported by Aysel et al. (2002). Disappearance of *C. scalpelliformis* has been associated with water pollution by these researchers [2]. Notification for record of this species from entrance of a harbour for the coasts of Turkey supports the possibility of transportation by bottom and anchors of vessels. In the present study this species was detected on rockless substrate at 15 m. It demonstrates that the species is still available in this area. The species was found not only in entrance of the marina but also distributed around the Great Harbour. Therefore it can be marked that it is a spreading species. In the present study it was determined that the species died in July at 26.5-27°C. It is estimated that the reason of detection of this species in February and March in Konyaalti Beaches is due to increasing of water temperature. *Caulerpa scalpelliformis* was not detected in more than 15 m depth along the coast of 7 km between Marina and Great Harbour. Presence of this species in shallow waters may be arisen from increase of water temperature (30-31°C) in the coast and movement of coast sediment by waves. The reasons of aggregation and poor growing in the region until Great Harbour are sandy bottom structure of the Gulf, movements in benthic by wave and difficulty in cling of organism onto the sediment. It is occured that the species spreads towards the west from first recorded area because of the currents. It indicates that the species may spread from Antalya to Kemer after this time. Although *C. scalpelliformis* has unfairable properties like coverable and cytotoxicity, it possesses the good developed rhizomes to avoid the underwater erosion. Monitoring of this species will provide the elaborate data about *C. scalpelliformis.*

References
1 - Ertan, Ö. O., Turna, I. I. and Cormaci, M., 1998. First record of *Caulerpa scalpelliformis* (Brown ex Turner) C.Ag. (Caulerpaceae, Chlorophyceae) from the Mediterranean coast of Turkey. *Tr. Jour. of Botany*, 22 (4): 285-287.
2 - Aysel,V.; Senkardesler, A.; Aysel, F.; 2002; Türkiye Denizlerine Gelen Yeni Bir Tehlikeli Alg *Caulerpa scalpelliformis* (R. Brown ex Turner) C. Ag. var. denticulata (Dacaisne) Weber van Bosse (Caulerpaceae, Caulerpales), *E.Ü. Su Ürünleri Dergisi*, 19 (1-2): 105 -108.
3 - Verlaque, M., Ruitton, S., Mineur, F. and Boudouresque, C.F. 2009. *CIESM Atlas of Exotic Macrophytes in the Mediterranean.*
4 - Womersley, H.B.S., 1984. The marine benthic flora of southern Australia. Part I, Gonvernment Printer, South Australia.
5 - Silva, P.C., Basson, P.W. and Moe, R.L., 1996. Catalogue of the benthic marine algae of Indian Ocean. University of California press.

DISTRIBUTION OF ANCHOVY AND SARDINE EGGS AND LARVAE IN THE NORTHERN AEGEAN SEA

Didem Gokturk [1]*, Taner Yildiz [1], Muammer Oral [2] and F. Saadet Karakulak [1]

[1] Istanbul University, Faculty of Fisheries, Department of Fisheries Technology, Ordu cad. No.200, 34470 Laleli- Istanbul, Turkey - didemgokturk@gmail.com

[2] Istanbul University, Faculty of Fisheries, Department of Marine Biology Ordu cad. No.200, 34470 Laleli- Istanbul, Turkey

Abstract

Preliminary results of distribution and abundance of anchovy (*Engraulis encrasicolus)* and sardine (*Sardina pilchardus*) eggs and larvae in the northern Aegean Sea was studied during the period of August 23-29, 2008. The spawning areas for anchovy are located in the northern coast of Foca (Izmir), Edremit Bay, and the area between the Saroz Bay and the north of Gökceada Island. Anchovy eggs and larvae were mainly distributed over the continental shelf. Few sardine eggs and larvae were collected.

Keywords: Ichthyoplankton, Larvae, Pelagic, Aegean Sea, Fishes

Introduction

Due to the rich nutrient content of the northern Aegean Sea which is becoming seawater rich with nutrients from the Black Sea and the Sea of Marmara, many rivers bringing 1000 m^3/s of fresh water flow into this part of the Aegean Sea [1]. This area is an important fishing ground for sardines, anchovy, chub and Atlantic mackerel. 62.5% of the sardines (13 088 t) and 2.2% of the anchovy (8390 t) catch in Turkish waters comes from the Aegean Sea [2].

Ichthyoplankton-based methods are increasingly being used around the world to estimate the biomass of fish stocks and monitor trends in fish abundance [3]. Ichthyoplankton researches conducted in the Turkish waters of the Aegean Sea are concentrated in Izmir Bay (central Aegean Sea). The aim of this paper is to give the results of ichthyoplankton research on the distribution and abundance of the anchovy and sardine eggs and larvae in the northern Aegean Sea.

Material and Methods

The samples were collected during an ichthyoplankton cruise onboard the R/V Yunus S in August 2008 in the northern Aegean Sea. A total of 13 sub-surface plankton horizontal tows with a Bongo net of 60 cm inlet diameter equipped with 250 µm mesh for oblique tows. The net was geared with general oceanic flowmeter for filtered volume estimates. All tows were fixed at 10 minutes duration. In each of the stations covered, a CTD (Seabird19+) was cast. All samples were preserved in 5% formaldehyde solution buffered with sodium borate.

In the laboratory all egg and larvae were removed, identified to the lowest possible taxon, counted and measured (diameter for eggs and standard length for larvae). The absolute number of eggs and larvae per haul was recorded and the relative number per 100 m^3 filtered water was calculated.

Results and Discussion

Survey area surface seawater ranged from 20.0 to 26.0°C, salinity from 34.7 to 39.4 psu, oxygen from 3.59 to 6.88 mg/l, and bathymetry from 40 to 330 m.

Anchovy eggs were found in three areas; namely in the northern coast of Foca (Izmir), Edremit Bay, and the area between the Saroz Bay and the north of Gökceada Island (Fig.1). Throughout the entire study area they were mainly located at the shelf ($\leqslant$100 m). Maximum egg abundance of 324 eggs/100 m^3 was recorded. The longitudinal diameter of the eggs varied between 0.91 and 1.32 mm, and the transverse diameter between 0.48 and 0.57 mm. Peak larval abundance was 125 larvae/100 m^3 and the size ranged from 2.50 to 9.02 mm SL. Eggs were more abundant than larvae. This is in agreement with existing knowledge of the reproductive period of this species which occurs from April to September with peaks usually in the warmest months [4].

Few sardine eggs and larvae were collected on this cruise (Fig.2). Maximum egg abundance of 14 eggs/100 m^3 was recorded. The diameter of the eggs varied between 0.67 and 1.13 mm. The length of the sardine larvae was 4.88 – 7.10 mm SL.

In a research conducted in the northern Aegean Sea (Greek waters), anchovy larvae were highly abundant in June 1996 [5]. According to our results, in the northern Aegean Sea (Turkish waters), anchovy egg and larvae were highly abundant in August 2008. The restriction of the Turkish Ministry of Agriculture and Rural Affairs of fish catch by purse seiners in the summer period (between 15 April and 1 September) is an appropriate regulation for the protection of the anchovy population. In the Mediterranean Sea, the anchovy is caught also by other nations. Therefore, a common fishing legislation should jointly be regulated with other fishing partners.

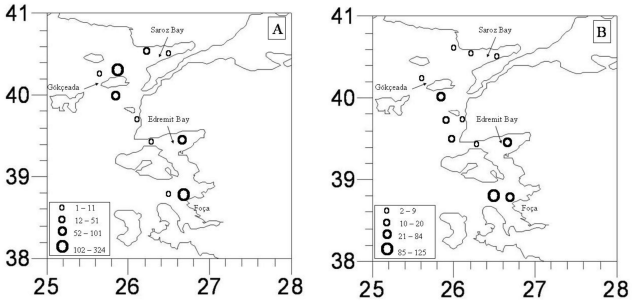


Fig. 1. Distribution and abundance of anchovy eggs (A) and larvae (B)

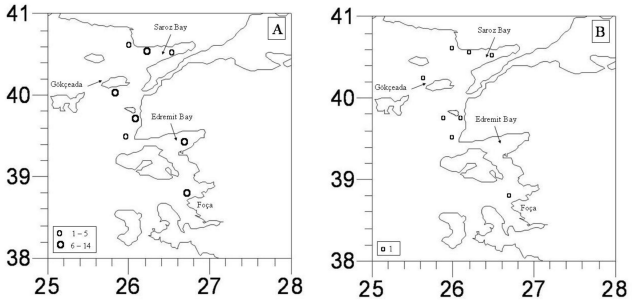


Fig. 2. Distribution and abundance of sardine eggs (A) and larvae (B)

References

1 - Kocatas, A., Bilecik, N., 1992. Ege Denizi ve Kaynaklari.T.C. Tarim ve Koyisleri Bakanligi Su Urünleri Arastirma Enstitüsü, Seri A, Yayin No:7, s.88, Bodrum (in Turkish).

2 - TUIK., 2007. Fisheries Statistics 2007. Turkish Statistical Institute,48 p., Ankara.

3 - Hunter, J.R., Lo, N.C.H., 1993. Ichthyoplankton methods for estimating fish biomass. Introduction and terminology. *Bull.Mar.Sci*.53:723–727.

4 - Turker, D., Hossucu, B., 2006. Distribution, Abundance and Mortality Rates of Eggs/Larvae of Anchovy Fish, *Engraulis Encrasicholus* (Linnaeus, 1758) In Edremit Bay (Aegean Sea, Turkey). BAU Fen Bil. Enst.Dergisi 8(2):4-12 (in Turkish).

5 - Somarakis, S., Drakopoulos, P.Filippou, V., 2002. Distribution and abundance of larval fish in the northern Aegean Sea, eastern Mediterranean, in relation to early summer oceanographic conditions. *Journal of Plankton Research*, 24(4):339-357.

THE IMPACT OF THE CIESM ATLAS OF EXOTIC SPECIES (FISHES) IN THE MEDITERRANEAN

D. Golani [1]*, L. Orsi-Relini [2], E. Massutí [3], J. Quignard [4], J. Dulcic [5] and E. Azzurro [6]
[1] Department of Evolution, Systematics and Ecology, The Hebrew University of Jerusalem, 91904 Jerusalem, Israel - dgolani@cc.huji.ac.il
[2] Laboratorio di Biologia Marina e Ecologia Animale, DIPTERIS, University of Genova, Italy
[3] IEO-Centre Oceanografic de les Balears, Palma de Mallorca, Spain
[4] Laboratoire d'Ichthyologie méditerranéenne, Université Montpellier II, France
[5] Institute of Oceanography and Fisheries, Split, Croatia
[6] ISPRA, High Institute of Environmental Protection and Research, Laboratory of Milazzo, Italy

Abstract
In 2002 CIESM published the first in its series of Atlases of Exotic Species in the Mediterranean, first on Fishes and on Decapods, then two years later on Molluscs. The Atlases provide user-friendly access to detailed and authoritative information on Mediterranean biodiversity to both amateurs and experts and raise the level of awareness of these important issues. A survey of electronic databases has revealed that the CIESM Atlas of Exotic Species: Fishes has been cited by close to 200 scientific articles.
Keywords: Alien species, Fishes, Eastern Mediterranean, Western Mediterranean

In 2002 CIESM published the first in its series of Atlases of Exotic Species in the Mediterranean, first on Fishes and on Decapods, then two years later on Molluscs.

Whereas the original and main goal was to document the existing situation concerning the dynamics of biodiversity in the Mediterranean, in light of ongoing changes, the very fact of the publication of the Atlases, and of the online Atlases via the CIESM website in the Internet, raised the level of awareness of these issues to the public. The Atlas provides user-friendly access to detailed information on Mediterranean biodiversity to both amateurs and experts.

Since the publication of the CIESM Atlases, there has been a notable increase in the number of exotic species in the Mediterranean, in all three taxa, but especially in molluscs. This dramatic increase may be attributed to the significant augmentation of collection activity, both by scientists and by amateur naturalists. In addition, most molluscs have hard shells which remain after their death, thus allowing detection of abortive colonization attempts; this is not possible concerning other taxa.

However, concerning fishes, there are other means of detecting the presence of exotic fish species in the Mediterranean. The fishery industries and fishermen, both commercial and amateurs, assist in the recognition of the arrival of species previously unknown in their new distribution areas. Furthermore, the quantitative biology and ecology of many fish species are well known, which is conducive to monitoring of the number and distribution of exotic fish species.

The Atlas of Exotic Species: Fishes [1] has become a known and leading authoritative baseline for researchers and others searching for accurate and updated information on the dispersal and distribution of exotic fish species in the Mediterranean Sea. A survey of electronic databases has revealed that the Atlas of Fishes has been cited by no less than 197 scientific articles. We the authors and members of the CIESM Fish Group estimate that the actual number of citations is much higher, since many important journals of regional or local interest and distribution may not necessarily be indexed by the standard databases and most popular online search engines.

The number of known citations of the Atlas has risen from 3 in the first year of its publication, 2002, to at least 45 in 2009. The citing publications have first authors from many nationalities, from no less than 23 different countries; the country with the most citations of the Atlas is Italy (with 38), then Greece (31), Israel (28), Tunisia (20) and Turkey (17).

In the future, the CIESM Atlas of Exotic Species, in its online format on the CIESM website, can continue to inform the scientific and general community of the presence of new exotic species that may constitute a threat to the health and safety of the public. For example, there are exotic fish species that are poisonous, such as *Lagocephalus sceleratus*, the Elongated Pufferfish [2, 3] or venomous, such as *Plotosus lineatus*, the Eel Catfish [4]. It is hereby suggested that the CIESM website add a page of recent scientific publications, including grey literature, on invasive species in the Mediterranean.

References
1 - Golani, D., Orsi-Relini, L, Massuti, E. and Quignard J –P., 2002. CIESM Atlas of Exotic Species in the Mediterranean. Vol.1. Fishes. (F. Briand, ed.), Monaco: CIESM Publications. 254 pp.
2 - Eisenman, A., Rusetski, V., Sharivker, D., Yona, Z. and Golani, D., 2008. An odd pilgrim in the Holyland. *Amer. J. Emerg. Med.* (electronic), 26: 383.e3-e6.
3 - Bentur, Y., Ashkar, J., Lurie, Y., Levy, Y., Azzam, Z., Litmanovich, M., Gurevych, B, Golani, D. and Eisenman, A. 2008. Lessepsian migration and tetrodotoxin poisoning due to *Lagocephalus sceleratus* in the eastern Mediterranean. *Toxicon*, 52: 964-968.
4 - Gweta S., Spanier, E. and Bentur, Y. 2008. Venomous fish injuries along the Israeli Mediterranean coast: scope and characterization. *Isr. Med. Assoc. J.* 10(11): 783-788.

A CONTRIBUTION ON THE DISTRIBUTION OF THE GIANT RED SHRIMP *ARISTAEOMORPHA FOLIACEA* (RISSO, 1827) ALONG THE AEGEAN SEA AND MEDITERRANEAN PART OF TURKEY

Onur Gönülal [1]*, Tahir Özcan [2] and Tuncer Katagan [3]
[1] Department of Marine Biology, Fisheries Faculty, Istanbul University - ogonulal@istanbul.edu.tr
[2] Department of Hydrobiology, Fisheries Faculty, Mustafa Kemal University
[3] Department of Marine Biology, Fisheries Faculty, Ege University

Abstract
The aim of this study is to provide information on the distribution of *Aristeomorpha foliacea* in the Aegean Sea and Mediterranean coast of Turkey. Samples were collected during surveys at various stations in South Aegean and North-East Mediterranean Sea from 2005 - 2008.
Keywords: Decapoda, Deep Waters, Aegean Sea, Eastern Mediterranean

The giant red shrimp is a commercially important, valuable species for deep water fisheries in Turkish coasts. It is heavily exploited in Western Mediterranean, and is currently fished in the Central Mediterranean; its stocks are pristine in the Eastern Mediterranean [1]. *A. foliacea* is more common than *A. antennatus* in the Eastern Mediterranean [2]. The species was rarely recorded in the Eastern Mediterranean while in The Aegean Sea, it appears in a few reports. Biological surveys were carried out in Marmaris 650 m (one male; 2005), Mersin Bay (20 male; 15 female; 2008) and Iskenderun Bay (103 male; 125 female; 2005); the species was also collected from the north of Ikaria Island (29 male, 43 female, 480 m, 2007), (Fig. 1).

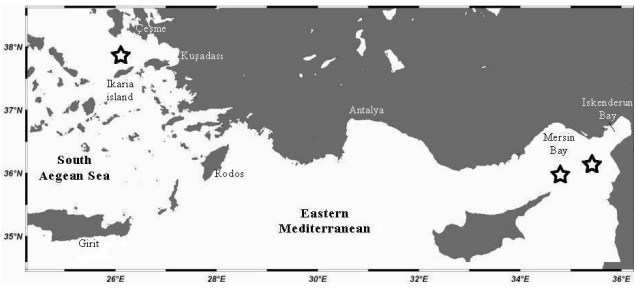


Fig. 1. Sampling areas along the Turkish coast

In some areas of the Aegean Sea their exploitation has recently started. The mean biomass indices recorded at the Mediterranean basin showed that *A. foliacea* was least abundant in the Aegean Sea [3]. A total of 336 specimens of *A. foliacea* were measured and sexed throughout the sampling area (Table 1). A prevalence of females can be generally observed, representing 55% of the sampled total, except for the Mersin Bay, where only 42% out of all individuals were females.

Tab. 1. Minumum, maximum and mean Carapace length (mm) and weight (g) for male and female in The sampling areas

Geographic Area	Significant (p<0.05)	Carapace Length (mm)				Weight (g)			
		Sex	Min	Max	Mean	Sex	Min	Max	Mean
Mersin Bay	North of Ikaria island (0,001)	♂	27,7	53	41,7	♂	9	16,9	13
	Iskenderun Bay (0,760)	♀	38,8	48,1	44,2	♀	11	17	13,9
Iskenderun Bay	Mersin Bay (0,760)	♂	24	49	35,7	♂	6,6	29,7	19
	North of Ikaria island (0,000)	♀	33	67	54	♀	13,9	71,2	41,1
North of Ikaria island	Mersin Bay (0,001)	♂	24,3	49,6	32,3	♂	8,1	27,2	15,3
	Iskenderun Bay (0,000)	♀	32,4	48,5	41,1	♀	11,2	38,8	22,5

Anova tests and Tukey test were used to compare the differences in the average carapace length for each geographic area; the median value of carapace length for A. foliacea differs significantly between North of Ikaria island (Aegean Sea) and Iskenderun Bay (Eastern Mediterranean) (Table 1). The differences in size may be attributed to one or more factors: the effects of different areas such as abiotic factors, fishing depth and fishing pressure. Sizes of giant red shrimp in deeper areas was relatively larger compared to the shallow depth zone [4]. For its population at commercial fishing depths (usually from 400 to 600 m) in Iskenderun Bay (Eastern Mediterranean), the total CPUE ranged from 0.94 kg/hr to 8 kg/hr, and the mean CPUE (± SD) and its variation coefficient were calculated as 4.76 ± 2.41 and 50.73% respectively; the ratios of giant red shrimp in the total catch and in the total shrimp catch were calculated as 22.45% and 64.61% respectively [5]. According to these data, it can actually be concluded that variability, both in the yields and in the sizes, appears particulary high for the species. These facts need to be more studied in order to clarify the causes that induce these differences.

Acknowledgment
The authors thanks Prof Dr Bayram ÖZTÜRK for the cruise opportunity.

References
1 - Bianchini M.L. and Ragonese S., 1994. Life cycles and fisheries of the deep-water red shrimps Aristaeomorpha foliacea and Aristeus antennatus. Proceedings of the International workshop held in the Istituto di Tecnologia della Pesca e del Pescato, Mazara del Vallo. N.T.R.-I.T.P.P. Special Publication, 3:1–87.
2 - Mytilineou C. and Politou C.Y., 1997. New references for the presence the red shrimp, *Aristeomorpha foliacea*, in the Greek waters. In: *5* Hellenic Symposium on Oceanography and Fisheries. Volume II, pp. 87-89.
3 - Cau A., Carbonell A., Follesa M. C., Mannini A., Norrito G., Orsi-Relini L, Politou C.Y., Ragonese S. And Rinelli P., 2002. MEDITS based information on the deep-water red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus* (Crustacea: Decapoda: Aristeidae). *Scientia Marina*, 66 (Suppl. 2):103 - 124
4 - Papaconstantinou C. and Kapiris K., 2002. The Biology of the giant red shrimp (*Aristeomorpha foliacea*) at an unexploited fishing ground in the Greek Ionian Sea. *Fisheries Research*, 62 (2003) 37-52
5 - Can M.F. and Aktas M., 2005. A Preliminary Study on the Population Structure and the Abundance of *Aristeomorpha foliacea* (Riso, 1827) (Decapoda: Natantia) in the Deep-Water of the Northeastern Mediterranean. *Crustaceana*, 78 (8):941-946.

THE INDO - MEDITERRANEAN; THE EMERGING OF A MANMADE BIOGEOGRAPHICAL PROVINCE

M. Goren [1]*, M. B. Yokes [2], B. S Galil [3], A. Diamant [3] and N. Stern [1]
[1] Department of Zoology, Tel Aviv University - gorenm@post.tau.ac.il
[2] Haliç University, Istanbul, Turkey
[3] Israel Oceanographic and Limnological Research

Abstract

A study of the near-shore fauna (to 40 m depth) in the eastern Mediterranean has revealed the domination of the fish fauna by Erythrean aliens in the south-east Levantine Sea. The number of alien species and their relative abundance decline with increasing distance from the Suez Canal. Some of the recently arrived species have established large populations and comprise a significant component of the Levantine marine biota.

Keywords: Levantine Basin, Fishes, Biodiversity, Alien species

The continuous invasion of biota into the Mediterranean through the Suez Canal (Erythrean invasion; Galil, 2008) and the recent rise in sea water temperature (European Environment Agency, 2007), have accelerated the expansion of Indo-Pacific fishes in the eastern Mediterranean. A study of the soft-bottom, shallow-water fish fauna (to 40 m depth) conducted in the south-eastern Levantine Sea (Ashdod, Israel) and along the northern Levantine Sea (Iskenderun Bay, Antalya, Turkey) compares the Erythrean alien fish fauna at the three sites. The preliminary results, based on examination of more than 250,000 specimens, have shown a domination of the fish fauna by Erythrean aliens along the south-east Levantine Sea, and a decline in their numbers with their increasing distance from the mouth of Suez Canal (Fig. 1). The proportions of alien species, (individuals and biomass) decrease between Israel, Iskenderun, and Antalya, whereas the average fish size increase: the smallest specimens were found in Ashdod and the largest in Antalya. A comparison of the fish communities at depths of 9-20, 20 and 40 m at Ashdod, revealed a depth gradient in the dominance of the alien species. In the shallower water the alien species comprise ca. 80% of the biomass and ca. 90% of individuals; at a depth of 20 m ca. 60% of the biomass and ca. 70% of individuals; and at 40 m the alien species comprise ca. 40% of the biomass and ca. 25% of individuals. The most abundant alien species (comprising over 5% of the total catch: biomass or/and individuals) are *Decapterus russelli* (Rüppell, 1830), *Nemipterus randalli* Russell, 1986, *Plotosus lineatus* (Thunberg, 1787), *Apogon smithi* (Kotthaus, 1970), *Lagocephalus suezensis* Clark & Gohar, 1953, *Saurida undosquamis macrolepis* (Richardson, 1848), and *Callionymus filamentosus* Valenciennes, 1837. The first four species have been recorded in the Mediterranean only in the past decade. Seasonal changes in abundance of the alien species were detected during the 18 months of the study. Their abundance were low during spring and early summer, and peaked during November and December. However, a comparison between the early stages of the study (spring and summer 2008) and the same months in the second year of the study reveals an increase in the proportion of aliens and significant changes in the proportions of the various species.

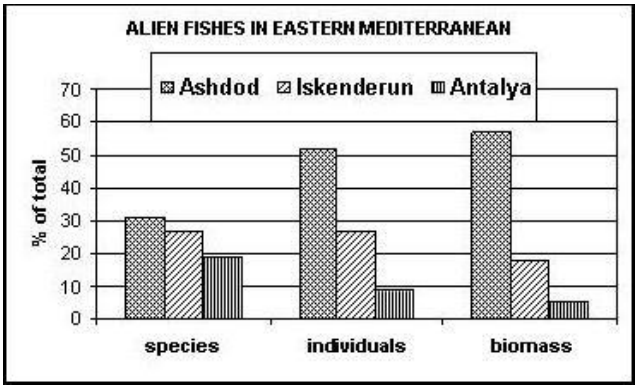


Fig. 1. A comparison of the number of Erythrean alien species, individuals and biomass at three sites in the Eastern Mediterranean.

References

1 - European Environment Agency, 2007. Europe's environment — The fourth assessment Document Actions. http://www.eea.europa.eu/data-and-maps/figures/total-sea-surface-temperature-changes-in-the-mediterranean-sea-oc-1982-2003

Galil B.S. 2008. Alien species in the Mediterranean Sea — which,when,where,why? *Hydrobiologia* 606:105-116.

COMPARISON OF ZOOPLANKTON ECOLOGY OF THE MEDITERRANEAN AND THE NORTH ATLANTIC

G. Gorsky [1]*, N. Daly Yahia [2], I. Siokou-Frangou [3], O. Ettahiri [4], M. G. Mazzocchi [5], M. Khelifi-Touhami [6], M. L. Fernandez De Puelles [7], H. Zakaria [8], K. Stefanova [9], E. Mutlu [10], S. Fonda Umani [11] and A. Gislason [12]

[1] CNRS/UPMC LOV, 06230 Villefranche sur mer, France - gorsky@obs-vlfr.fr
[2] University 7 November, Carthage. Faculty of Sciences of Bizerte, Tunisia
[3] HCMR, PO Box 712. 19013 Anavyssos Attikis, Greece
[4] INRH, Département d'Océanographie et d'Aquaculture, Casablanca, Morocco
[5] SZN, Villa Comunale, 80121 Napoli, Italy
[6] Université Badji Mokhtar, Annaba 23 000, Algérie
[7] CSIO, 07080 Palma de Mallorca, Spain
[8] NIOF, Kayet Bey, Alexandria, Egypt
[9] BAS, Bulgarian Academy of Sciences, 9000 Varna
[10] Dokuz Eylul University, Inciralti, Izmir, Turkey
[11] University Of Trieste, v. Valerio 28/1 34123 Trieste, Italy
[12] MRI, Skulagata 4, Reykjavik, Iceland

Abstract

Zooplankton is a key link between primary producers and larger predators and most zooplankton population changes can be attributed to environmental causes. Multi-year zooplankton time series provide an important tool for examining climate-ecosystem interactions. The CIESM Zooplankton Indicators program developed comparative studies of bio-geographical variations across the sea basins through international co-operation and through the constitution of networks of institutes and experts.

Keywords: Zooplankton , Biogeography, Time Series, Sampling Methods, Global Change

Mediterranean Sea is oligotrophic with low fisheries production, similar to the subtropical part of the North Atlantic; nevertheless the extraordinarily rich variety of singularities driving ocean life and biogeochemical dynamics of this enclosed sea makes more critical its sustainable use by the surrounding human populations. The North Atlantic encompasses several highly productive sea areas around its continental shelf margins that provide work and living to local communities. While there are important differences between these two ecosystems, they also share several common features and belong to the same ecosystem type or biome as defined by Longhurst (1998, The Ecological geography of the Sea), given that the greatest number of species in the Mediterranean Sea are of Atlantic origin.

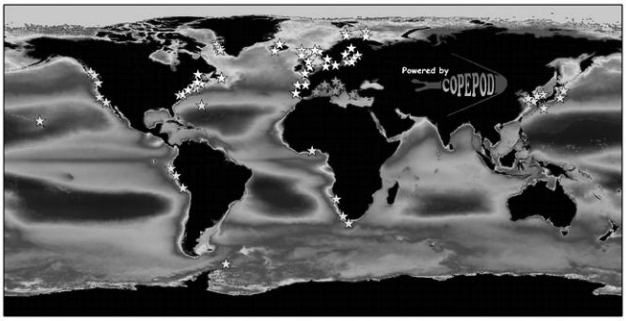


Fig. 1. World map long-term series of zooplankton from COPEPOD's analytical and data processing www.st.nmfs.noaa.gov/plankton. In green, the Mediterranean series, structured through the CIESM Zooplankton Indicators Program.

Both areas have a strong history of plankton research. In the Mediterranean and the Black Sea, the Mediterranean Science Commission's (CIESM) Zooplankton Indicators Program supports a network of marine researchers from 23 member states, applying the latest scientific tools to better understand, monitor and protect their fast changing and highly impacted sea areas. In the North Atlantic, The ICES Working Group on Zooplankton Ecology (WGZE), reviews sampling and analysis technologies, and monitors zooplankton sampling activities. In the framework of their activities both groups developed interactions with the aim to mutually enrich the marine zooplankton research activities (fig. 1).

The terms of reference of this collaboration were:
a) review and consider comparison of zooplankton ecology of the Mediterranean and the North Atlantic, with emphasis on common species and size structure using common numerical methods;
b) review and consider overview of on-going time-series programmes;
c) review and consider harmonization of methods, overview of experimental work;

The web page (http://www.wkzem.net/), hosted at the NOAA-NMFS, Science and Technology gives detailed information on the activity undertaken in a form of a workshop organized in Heraklion, Crete, in October 2008. The zooplankton time series results are expressed in a consistent form (see fig. 2 and the site address in the legend of fig 1).

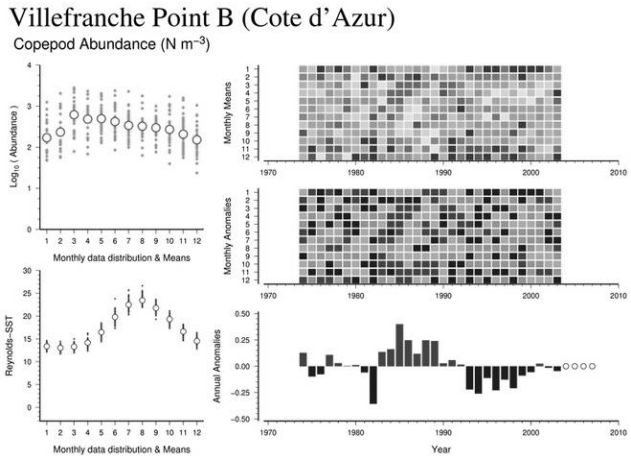


Fig. 2. Standard analysis plots (distrograms, histograms, means and anomalies) of the Villefranche Point B dataset consists of more than 30 years of samples collected off Villefranche at 43°41 N 07°19 E. Samples were collected by a vertical tow from bottom to surface (75-0 m), using a Juday-Bogorov net (330 µm mesh). Copepod abundance was counted from ongoing and historical samples using the wet-bed image scanning technique of ZooScan (Gorsky et al., in press). Copepod abundance was highest during the well-mixed winter period, followed by a general decline, with rising water temperatures and increasing stratification.

The different activities undertaken in the framework of the CIESM program on Zooplankton Indicators and the main achievements will be presented.

References

1 - Gorsky et al. In press. Digital zooplankton image using the ZooScan integrated system. *J. Plankt. Res.*

NUMERICAL SIMULATIONS OF SMALL PELAGIC FISHES EGGS AND LARVAE IN THE ADRIATIC SEA

R. Gramolini [1], A. Russo [1]*, A. Coluccelli [1], M. La mesa [2], M. Panfili [2], E. B. Morello [2] and E. Arneri [3]
[1] Dept. of Marine Science, Polytechnic University of Marche - a.russo@univpm.it
[2] Institute of Marine Sciences, CNR, Ancona, Italy
[3] Fisheries and Aquaculture Department, FAO, Rome, Italy

Abstract
An Individual Based Model (ICHTYOP) was applied in the Adriatic Sea with the aim of studying the mechanisms regulating spawning and recruitment success of small pelagic fishes. ICHTYOP numerical simulations have been driven by realistic current fields derived by an hydrodynamic model, and outputs were analyzed in a GIS environment. Preliminary results indicate that most recruits are along the western Adriatic coast and that the total interannual variability could be low compared to monthly variability. Specific simulations driven by position and ages of larvae caught in the Gulf of Manfredonia provide interesting insights for this important nursery area.
Keywords: Adriatic Sea, Spawning, Recruitment, Larvae, Models

Introduction.
The fishery for small pelagic, particularly for anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*), is important in the Adriatic Sea, being the largest of the Mediterranean Sea. Anchovy and sardine are species with a short life cycle, so a key factor regulating their abundance is recruitment success which in turn is considerably influenced by the passive transport from spawning areas to recruitment areas.

Materials and Methods.
Transport of small pelagic fishes eggs and larvae has being studied within the framework of the EU project "SARDONE" by using an Individual Based Model (IBM), ICHTYOP [1], already used in similar studies conducted in other areas with relevant small pelagic fisheries like the Benguela Current and the Peru upwelling systems. Realistic environmental conditions (in particolar 3-D currents and temperature over the whole Adriatic Sea) were provided to ICHTYOP as daily averages of the Regional Ocean Modelling System (ROMS; [2]) outputs. The Adriatic ROMS implementation is adequate to resolve mesoscale features (two numerical grids are being using, one with a resolution variable between 3 and 12 km and the other with constant spacing of 2 km; both having 20 *s*-levels in vertical). ROMS deduces fluxes of momentum, heat and water through the air-sea interface from outputs of a high resolution operational atmospheric model, COSMO-I7, managed by the Hydro-Meteo-Clima Service of ARPA Emilia-Romagna (Bologna, Italy), in agreement with the Meteorological Office of the Italian Air Force and Piemonte Region.
The whole Adriatic basin was arbitrarily divided into 36 regions according to morphology, bathymetry and general circulation. For a preliminary trial aiming to investigate the general behavior of the basin, eggs were released in ICHTYOP from each of the 36 regions (in a number proportional to the respective areal surface) and their trajectories followed for 60 days, representing the maximum duration of the passive larval transport. Eggs were released every 10 days during two years characterized by contrasting environmental characteristics (in terms of Po River runoff and wind stress). After 3 days, larvae hatch from eggs, and larval diel vertical migration was considered in the ICHTYOP run. The numeric outputs have been collected in a database for subsequent analysis in GIS, allowing for rapid and extensive result summaries and for more detailed studies.

Results and Discussion.
The GIS analysis of the ICHTYOP simulations provided the following main results: sea currents transport larvae ready to recruit in high concentration along the western Adriatic coast, especially in the central area, whilst very low concentrations are present on the eastern part of the basin (fig. 1); monthly variability is relevant; overall there are almost no differences between the two contrasting years, but there are differences in the monthly distributions.
ICHTYOP was applied also in "backward" mode to carry out a data-driven study. During two surveys conducted in the Gulf of Manfredonia (southern Adriatic Sea, Fig. 1), anchovies and sardine larvae were caught and their ages estimated by otholith microincrement counts. The Gulf of Manfredonia is known as an important recruitment area, hosting a valuable larval fishery, but it is not considered a spawning area. ICHTYOP integrations starting from date and position of anchovy and sardine larvae catches going backward up to their spawning date demonstrate a full consistency with known spawning areas.

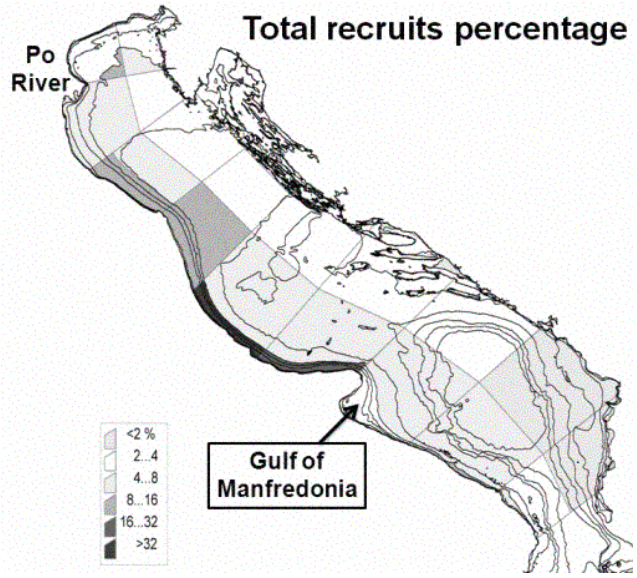


Fig. 1. Percentage of total recruits in the 36 regions chosen for the Adriatic Sea as resulting from two years of ICHTYOP exploratory simulations

References
1 - Lett C., Verley P., Mullon C., Parada C., Brochier T., Penven P., Blanke B., 2008. A Lagrangian tool for modelling ichthyoplankton dynamics. *Environ. Modell. Softw.*, 23:1210-1214.
2 - Haidvogel D.B., Arango H., Budgell W.P., Cornuelle B.D., Curchitser E., Di Lorenzo E., Fennel K., Geyer W.R., Hermann A.J., Lanerolle L., Levin J., McWilliams J.C., Miller A.J., Moore A.M., Powell T.M., Shchepetkin A.F., Sherwood C.R., Signell R.P., Warner J.C. and Wilkin J., 2008. Ocean forecasting in terrain-following coordinates: Formulation and skill assessment of the Regional Ocean Modeling System. *J. Comput. Phys.*, 227: 3595-3624.

FEEDING HABITS OF THE SMALL-SPOTTED CATSHARK *SCYLIORHINUS CANICULA* (L., 1758) IN THE CENTRAL MEDITERRANEAN

Francesca Gravino [1], Mark Dimech [2] and Patrick J. Schembri [1]*
[1] Department of Biology, University of Malta, Msida MSD2080, Malta - patrick.j.schembri@um.edu.mt
[2] Ministry for Resources & Rural Affairs (Capture Fisheries), Fort San Lucjan, Marsaxlokk, Malta

Abstract
Scyliorhinus canicula collected from 45 stations during the MEDITS annual bottom trawl survey had a Total Length range of 14-52 cm; males were more abundant than females. Of 532 stomachs sampled, 74.4% had identifiable prey material that indicated opportunistic feeding on a wide range of macrobenthic fauna. Teleosts and crustaceans were the most important prey groups (58.7 %/w and 19.3 %/w respectively). Cannibalism was also observed. There were significant differences in diet composition between the sexes and between different size classes for males and females combined.
Keywords: Elasmobranchii, Fisheries, Food Webs, Sicilian Channel

Introduction
The catshark *Scyliorhinus canicula* is a common demersal elasmobranch in the Mediterranean. It has a wide geographical distribution and a bathymetric distribution ranging from shallow water to 550 metres depth, and is found primarily over sandy, muddy or gravelly bottoms [1]. Studies on the feeding habits of *Scyliorhinus canicula* have been made in various regions but not to date in the Central Mediterranean; the present study addresses this gap by presenting information on the diet of the species for this region, for the first time.

Material and Methods
The study was conducted in the General Fisheries Commission for the Mediterranean's Geographical Sub-Area (GSA) 15. Samples were collected in June 2006 from 45 stations as part of the ongoing MEDITS (Mediterranean International Trawl Survey) annual bottom trawl survey (Fig.1). For each specimen, total length, weight, sex and maturity stage were recorded. For males, the maturity stage determination was based on the length and degree of calcification of the pterygopods, while for females, determination was based on the degree of development of the distal part of oviducts and of the shell gland, on the presence of embryos, and on the dimensions of the eggs in the ovary [2]. In all, 532 stomachs were extracted; these were weighed, dissected and rinsed with 70% ethanol to ensure that all contents were removed, and the emptied stomachs were re-weighed to estimate the fullness of the stomach. The prey items were identified to the lowest possible taxon then weighted separately to the nearest 0.001 grams. Individual catsharks were checked for any signs of regurgitation. Stomach contents were analyzed using numerical percentage (N%) and percentage by weight (W%). Statistical differences in feeding habits in relation to size and sex were assessed using the Kruskall-Wallis and Mann-Whitney tests.

Results
A total of 652 catsharks were caught from 25 of the 45 stations sampled. The fish ranged from 14 cm to 52 cm total length and from 6 g to 437 g in weight. Males were more abundant than females (sex ratio 1:0.75). Of the 532 stomachs examined, 33 (6.2%) showed signs of regurgitation, 103 (19.4%) were empty, and 396 (74.4%) contained prey. In all, 26 prey taxa were identified. The main prey items by weight were teleost fish (58.67%, dominated by *Trachurus trachurus* and *Macroramphosus scolopax*), crustaceans (19.25%, dominated by *Alpheus glaber* and *Chlorotocus crassicornis*), unidentified octopuses and cuttlefish (16.36%), polychaetes of the family Aphroditidae (3.89%) and a small percentage of *Posidonia oceanica* leaves (0.06%) and abiotic material (0.77%). One specimen had a juvenile *S. canicula* in a primary state of digestion in its stomach, which suggested cannibalism (1%/w). The abundance of food items by mass varied significantly between the different categories (One-way ANOVA, $P < 0.001$), and this was accounted for by the 'fish' category (Tukey post-hoc test, $P < 0.05$). Significant differences in the weight of the different stomach content items were observed between mature males and females (Mann-Whitney U-test, $P < 0.05$). Mature males consumed significantly more fish than did females, which consumed more crustaceans. Diet also differed between the different size classes (Kruskall-Wallis test, $P < 0.05$).

Discussion
Central Mediterranean *Scyliorhinus canicula* were found to have a high dietary diversity and to feed opportunistically on a wide range of macrozoobenthos and also on abiotic material, showing both predatory and a facultative scavenging, as reported by [3] for Isle of Man waters. The presence of small catsharks in the stomach contents showed that there is also some degree of cannibalism. The composition of the diet varied significantly with size as the larger and more mature individuals showed an increasing preference for fish and cephalopods, while smaller individuals showed a preference for crustaceans, probably because large individuals are able to ingest larger food items such as fish. The preference for fish was more pronounced in mature males than in mature females, which may be related to sexual dimorphism in the shape of mouth and teeth at maturity [4].

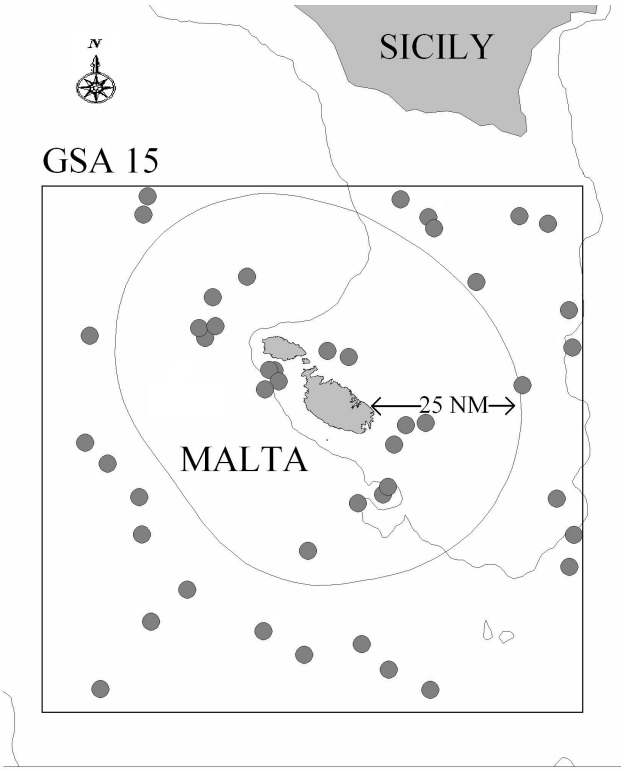


Fig. 1. Map showing the position of General Fisheries Commission for the Mediterranean's GSA 15 (the square) and the 45 stations sampled (the dots). The 25 nautical mile Fisheries Management Zone around Malta is also shown.

References
1 - Serena F., 2005. Field identification guide to the sharks and rays of the Mediterranean and Black Sea. Rome, Italy: Food and Agriculture Organization of the United Nations; 97 pp.
2 - Relini G., Carpentieri P., Murenu M., 2008. Manuale di Istruzione MEDITS (MEDITS Instruction Manual). *Biol. Mar. Mediterr.* 15 (2): 1-78.
3 - Lyle J.M., 1983. Food and feeding habits of the lesser spotted dogfish, *Scyliorhinus canicula* (L.), in Isle of Man waters. *J. Fish Biol.*, 23**:** 725-737.
4 - Ellis J.R., Shackley S.E., 1995. Ontogenic changes and sexual dimorphism in the head, mouth and teeth of the lesser spotted dogfish. *J. Fish Biol.*, 47**:** 155-164.

FEEDING HABITS OF INDO-PACIFIC SPECIES *NEMIPTERUS RANDALLI* RUSSEL, 1986 (NEMIPTERIDAE) IN ISKENDERUN BAY, EASTERN MEDITERRANEAN SEA

M. Gurlek [1]*, S. Erguden [2], D. Yaglioglu [1], F. Turan [1], S. Demirhan [1], M. Gurlek [1], M. Gungor [1], B. Ozbalcilar [1] and T. Ozcan [1]
[1] Mustafa Kemal Univerity, Fisheries Faculty - cturan@ymail.com
[2] Cukurova University, Fisheries Faculty, Department of Basic Science

Abstract
Diet of threadfin bream *Nemipterus randalli* was determined from the specimens collected in Iskenderun Bay, Eastern Mediterranean Sea. A total of stomach contents of 117 threadfin bream specimens with total lengths ranging from 7.0 cm to 26.6 cm were examined. Stomach content analysis revealed that this species is carnivorous, feeding on benthic crustaceans constituting the main food in the overall diet composition. Main food items found in the stomach were crustaceans (IRI%= 82.29). Other main prey items found were pisces (IRI%= 12.83) polychaeta (IRI%= 1.18) and mollusca (IRI%= 0.03). Therefore rapidly expanding population of *N. randalli* may damage crustacean biodiversity and fish stocks feeding on crustaceans.
Keywords: Diet, Teleostei, Eastern Mediterranean

Introduction
The threadfin bream *Nemipterus randalli* is the first representative of the family Nemipteridae in the Mediterranean Sea, and recorded for the first time for the Mediterranean Sea by Bilecenoglu & Russel [1] based on a few specimen collected from the eastern coast of Iskenderun Bay, Turkey. This species has rapidly extended and now succesfully established in Eastern the Mediterranean Sea [2,3,4]. *N. randalli* is very abundant in coastal waters, found on mud or sand bottoms in 5 to 80 m, usually in schools [5]. *N. randalli* has a widespread distribution found in the Indian Ocean and West Pacific. It is considered commercially important throughout its distribution, and one of the major species in the southern Red Sea and in the Gulf of Suez [6,7]. In the near future *N. randalli* may be a valuable commercial species in the Mediterranean Sea. Despite its abundance and new establishment along Turkish coast, no studies concerning the feeding regimes to the Mediterranean habit of *N. randalli* exists. In this study, the first time was to examine the feeding habits of threadfin bream caught in Iskenderun Bay, Eastern Mediterranean Sea.

Material and Methods
A total of 117 threadfin breams were collected during between 2009 from Iskenderun Bay (Eastern Mediterranean Sea). Specimens were caught by a R/V Mustafa Kemal I and commercial trawlers at a water depths ranging from 13 to 60 m under the project (TAGEM-09/AR-GE/11). After catching the fishes, stomachs were removed onboard, preserved in formalin and taken to the laboratory for analysis of the contents. In the laboratory, a total of 117 stomachs were dissected and then contents were identified to the lowest practical taxon (Table1). Prey were counted under a stereomicroscope and weighed to the nearest 0.01 g. Stomach contest was analyzed using the percentage frequency of occurrence (F%), percentage numerical abundance (N%), percentage gravimetric composition (W%) and index of relative importance; [IRI = (N%+W%) x F%] were determined [8]. IRI was expressed as a percentage; [IRI% = (IRI x 100) / ΣIRI].

Results and Discussion
Stomach contents of *N. randalli* specimens with total lengths ranging from 7.0 cm to 26.60 cm were examined (average total length= 13.12 cm). Of the stomach examined, 105 (90%) were full and 12 (10%) empty. A total of 305 prey items belonging to four taxa were determined. Crustacea were the most important group in the diet of *N. randalli* with IRI% 82.29, followed by pisces were second in importance, IRI% 12.83. Other main prey items found in the stomach were polychaeta (IRI%= 1.18) and mollusca (IRI%= 0.03) (Table 1). Diet composition of *N. randalli* from Iskenderun Bay revealed that this species carnivorous, expecially consuming benthic decapod crustaceans as primary food. The results demonstrated that *N. randalli* feed primarily on crustaceans, particularly *Processa sp*. *N. randalli* stomachs contained crustaceans (W=70%) and small fishes (W=18%). Similar result were obtained for the other *Nemipterus* species (*Nemipterus marginatus*)in the South China Sea, where mainly consumed crustaceans (70%) in particular *Penaeus sp*. constitued the major proportion of the diet composition (59.1%) [9]. The results demonstrated that *N. randalli* prefers crustaceans (Copepoda, Decapoda, Natantia, Brachyura, and Stomatopoda) as the main food, followed by teleost prey and polychaeta. The results suggested that the rapid extension of this fish species could be high the availability and distribution of food crustaceans. Therefore rapidly expanding population of *N. randalli* may damage crutacean biodiversity and fish stocks feeding with crustaceans. This information is very important in the management of fishery resources as well as for the efficient utilization of this species.

Tab. 1. Diet composition of *Nemipterus randalli* (N%: numerical composition, F%: frequency of occurence, W% gravimetric composition, IRI%: percentage index of relative importance)

SPECIES	%N	%F	%W	%IRI
POLYCHAETA				
Polychaeta sp	2.30	3.81	6.46	1.18
CRUSTACEA				
Copepoda				
Copepoda sp	3.28	7.62	0.47	1.01
Decapoda				
Natantia				
Alpheus sp.	0.98	1.90	2.61	0.24
Alpheus rapacida	1.31	1.90	4.93	0.42
Processa sp	60.3	19.0	42.2	68.9
Portunidae sp	0.33	0.95	0.36	0.02
Brachyura				
Macrophthalmus graeffei	0.33	0.95	0.36	0.02
Goneplax rhomboides	0.98	1.90	4.06	0.34
Ocypodidae sp	1.31	2.86	2.42	0.38
Unidentifed shrimp	2.95	5.71	4.28	1.46
Unidentifed crab	9.51	15.2	8.10	9.47
Stomatopoda				
Stomatopoda sp	0.33	0.95	0.65	0.03
MOLLUSCA				
Bivalvia				
Bivalvia sp	0.33	0.95	0.51	0.03
PISCES				
Unidentified fish	4.92	12.4	12.8	7.76
Digested Fish	6.23	12.4	5.37	5.07
DIGESTED MATERIAL	4.59	11.4	4.43	3.64

References
1 - Bilecenoglu M. and Russel B., 2008. Record of *Nemipterus randalli* Russell, 1986 (Nemipteridae) from Iskenderun Bay, Turkey. Cybium, 32(3): 279-280.
2 - Gökoglu M., Güven O., Ahmet B.B., Çolak H. and Golani D., 2008. First records of *Nemichthys scolopaceus* and *Nemipterus randalli* and second record of *Apterichthus caecus* from Antalya Bay, Southern Turkey. *JMBA2 - Biodiversity Records*,1-3.
3 - Lelli S., Colloca F., Carpentieri P. and Russell B.C., 2008. The threadfin bream *Nemipterus randalli* (Perciformes: Nemipteridae) in the eastern Mediterranean Sea. *J. Fish Biol*., 73: 740–745.
4 - Erguden D., Turan C. and Gurlek M., 2009. Weight–length relationships for 20 Lessepsian fish species caught by bottom trawl on the coast of Iskenderun Bay (NE Medit. Sea, Turkey). *J. Appl. Ichthyol*., 25. 133-135.
5 - Russell B.C., 1990. Nemipterid fishes of the world. (Threadfin breams, whiptail breams, monocle breams, dwarf monocle breams, and coral breams). Family Nemipteridae. An annotated and illustrated catalogue of nemipterid species known to date. *FAO Fish. Synopsis* 125 (12): 1-149.
6 - Ben-Yami M., 1964. Report on the Fisheries in Ethiopia. Jerusalem: Department for International Cooperation, Ministry for Foreign Affairs, State of Israel.
7 - Ben-Tuvia A. and Grofit E., 1973. Exploratory trawling in the Gulf of Suez, November, 1972. *Fish. Fish. breed*., Israel, 8: 8-16.
8 - Hyslop, E.J., 1980. Stomach contest analysis: a review methods and their application. *J. Fish Biol*., 17, 411-429.
9 - Ibrahim S., Muhammad M., Ambak M.A., Zakaria M.Z., Mamat A.S., Isa M.M. and HajIsamae S., 2003. Stomach contents of six commercially important demersal fishes in the south China Sea.*Turk. J. Fish. Aquat. Sci*., 3: 11-16.

CARACTÉRISATION MORPHOLOGIQUE ET GÉNÉTIQUE DES POPULATIONS LAGUNAIRES DE *LITHOGNATHUS MORMYRUS* DES CÔTES TUNISIENNES

Ibtissem Hammami [1]*, Lilia Bahri-sfar [1] and Oum kalthoum Ben hassine [1]

[1] Unité de Recherche de Biologie, Ecologie et Parasitologie des Organismes Aquatiques, Faculté des Sciences de Tunis, Campus Universitaire 2092, Tunis, Tunisie - hammamibtissem@gmail.com

Abstract

L'étude de la variabilité morphologique de trois échantillons lagunaires de *Lithognathus mormyrus* (*Linnaeus*, 1758) nous a permis de mettre en évidence une nette hétérogénéité morphologique entre ces échantillons. Cette hétérogénéité est liée principalement à la forme de la tête qui semble être en relation avec le régime alimentaire ainsi que la disponibilité, la taille et le type de proies. L'analyse de la variabilité allozymique de ces mêmes échantillons n'a montré de différences qu'entre les deux échantillons des lagunes d'El Biban et de Bizerte.

Keywords: Fishes, Lagoons, Western Mediterranean

Lithognathus mormyrus est l'une des espèces les plus importantes de la famille des Sparidés. Il s'agit d'une espèce essentiellement marine, mais elle est fréquemment rencontrée dans les lagunes et les estuaires, considérés comme des nurseries pour les juvéniles.

Dans cette étude, nous nous proposons d'analyser la variabilité aussi bien morphologique que génétique de trois populations lagunaires des côtes tunisiennes de *Lithognathus mormyrus*. Deux lagunes sont situées dans le secteur Nord-est (lagunes de Bizerte et de Ghar El Melh) et la troisième est située dans le secteur Sud-est (lagune d'El Biban). L'étude morphométrique est basée sur l'approche de « Truss » [1]. L'identification de 18 points repères (landmarks), nous a permis d'établir un réseau de 41 mesures. L'étude génétique a concerné le polymorphisme de sept loci enzymatiques (EST-1, EST-2, GOT-2, IDH-2, MDH-3, PGM et SOD).

L'analyse de la variance des données morphométriques, après transformation allométrique [2], a montré des différences hautement significatives entre les trois échantillons lagunaires étudiés et ce, pour 29 variables parmi les 41 choisies. L'analyse factorielle discriminante a permis de mettre en évidence une nette discrimination des trois échantillons analysés selon l'axe 1 qui explique 56% de la variabilité totale. Les plus fortes contributions ont été apportées par des mesures liées principalement à la longueur de la partie antérieure (la Tête). Cette différenciation s'expliquerait par l'hétérogénéité environnementale de ces lagunes. L'alimentation constituerait un important facteur pouvant influencer la morphologie de la tête [3], [4].

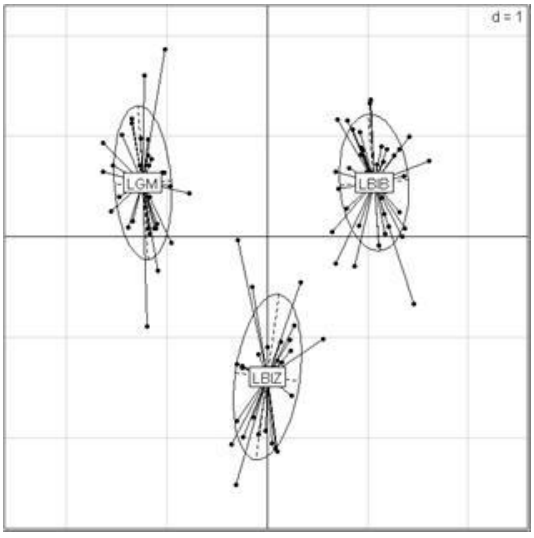


Fig. 1. AFD des variables morphométriques selon le plan formé par DF1 et DF2. LGM : lagune de Ghar El Melh ; LBIZ : lagune de Bizerte ; LBIB : lagune d'El Biban.

L'estimation de la diversité génique de Nei (Hnb*)* montre que l'échantillon de la lagune d'El Biban présente la valeur la plus faible. La valeur du F_{IS} global montre un déficit significatif en hétérozygotes (f = 0.3522 ; p < 0.001) principalement généré par le locus IDH-2. Le calcul de l'estimateur du F_{ST} de Wright montre une hétérogénéité entre les échantillons des lagunes de Bizerte et d'El Biban (θ = 0.0445 p <0.01) qui s'explique par des différences de fréquences alléliques au niveau des loci GOT-2 et EST-2. Ainsi, les différences morphologiques observées entre les échantillons des lagunes de Bizerte et d'El Biban reflèteraient à la fois les différences génétiques et la variabilité des facteurs environnementaux.

References

1 - Strauss R.E. and Bookstein F.L., 1982. The truss: body from reconstructions in morphometrics. *Syst. Zool.*, 31: 113-135.

2 - Reist J.D., 1985. An empirical evaluation of several univariate methods that adjust for size variation in morphometric data. *Can. J. Zool.*, 63: 1429-1439.

3 - Delariva R.L. and Agostinho A.A., 2001. Relationship between morphology and diets of six neotropical loricariids. *J. Fish. Biol.*, 58: 832-847.

4 - Palma J. and Andrade J.P., 2002. Morphological study of *Diplodus sargus, Diplodus puntazzo*, and *Lithognathus mormyrus* (Sparidae) in the Eastern Atlantic and Mediterranean Sea. *Fish. Res.*, 57: 1-8.

REPARTITION DE *SYNGNATHUS ABASTER* ET *SYNGNATHUS TYPHLE RONDELETI* (SYNGNATHIDAE) DANS LA LAGUNE NORD DE TUNIS

Dhekra Hayouni [1], Abdessalem Shili [1]*, Mariem Fadlaoui [1] and Naceur Ben Maïz [2]
[1] Institut National Agronomique de Tunisie, 1082, Tunis - shili.abdessalem@inat.agrinet.tn
[2] Société De Promotion Du Lac De Tunisie, 1080 Tunis

Abstract
Une campagne cartographique réalisée au printemps 2009 dans la lagune Nord de Tunis nous a permis de décrire la répartition spatiale de deux espèces de la famille des syngnathidés, le syngnathe de lagune *Syngnathus abaster* Risso, 1827 et le siphonostome de Méditerranée *Syngnathus typhle rondeleti* De la Roche, 1809. Cette répartition est étroitement liée à la nature des herbiers ainsi qu'à la profondeur de l'eau.
Keywords: Fishes, Lagoons, Mapping

Introduction
La lagune Nord de Tunis, peu profonde, est située au fond du golfe de Tunis entre les parallèles 36° 45' et 36° 52' de latitude nord 10° et 10° 20' de longitude est. Après les travaux de restauration, menés en 1985, cet écosystème lagunaire a montré une diversification biologique appréciable [1], [2], notamment pour les syngnathidés ; différentes espèces y ont été décrites telles que : *Syngnathus abaster* Risso, 1827, *Syngnathus typhle rondeleti* De la Roche, 1809, *Syngnathus acus* Linnaeus, 1758 et *Nerophis ophidion* Linnaeus, 1758 [3]. Ce travail porte sur la répartition de *Syngnathus abaster* et *Syngnathus typhle rondeleti* dans la lagune Nord de Tunis.

Matériel et méthodes
La campagne de cartographie réalisée au printemps 2009 avait pour objectif de décrire la répartition spatiale des deux syngnathidés S*yngnatus abaster* et S*yngnatus typhle rondeleti*. Leurs distributions ont été étudiées en rapport avec les macrophytes benthiques, notamment les deux espèces dominantes dans le milieu d'étude : la Magnoliophyte *Ruppia cirrhosa* (Petagna) Grande et la Chlorobionte *Chaetomorpha linum* (O.F. Müller) Kützing. Cette répartition a été étudiée suivant 19 transects distants de 500 m répartis sur l'ensemble du milieu lagunaire, moyennant un petit chalut benthique ayant un maillage de 1 mm.

Résultats et discussion
La répartition spatiale de *Syngnathus abaster* montre une présence importante dans la lagune Nord de Tunis et surtout dans la partie Sud de la lagune (fig. 1). Cette espèce est également rencontrée à l'est de la lagune et plus particulièrement au nord-est, zone fortement influencée par les échanges avec la mer. Ayant une taille ne dépassant pas les 12 cm, *Syngnathus abaster* est l'espèce la plus fréquente dans la lagune. Toutefois la répartition de *Syngnathus typhle rondeleti*, fragmentaire, est limitée à l'est de la lagune. Cette espèce, peu fréquente, est plus présente au sud-est de la lagune. Cette distribution est étroitement corrélée à celle des macrophytes benthiques et à la profondeur de l'eau. Les deux espèces de Syngnathidés ont été observées dans les herbiers à dominance *Chaetomorpha linum* et au niveau des zones à faibles profondeurs (inférieures a 0,8 m). La diversité et la fréquence des syngnathidés n'ont cessé d'augmenter dans la lagune Nord de Tunis après son assainissement. Ces espèces ont trouvé dans les herbiers à Magnoliophytes marines et dans les touffes à *Chaetomorpha linum* un refuge et un lieu de ponte. D'autres campagnes doivent être réalisées pour étudier l'évolution saisonnière de cette répartition. Par ailleurs, il est important, également, de comparer les variations saisonnières de la répartition des syngnathes à celles des macrophytes benthiques, particulièrement *Ruppia cirrhosa* et *Chaetomorpha linum* qui dominent dans la lagune Nord de Tunis.

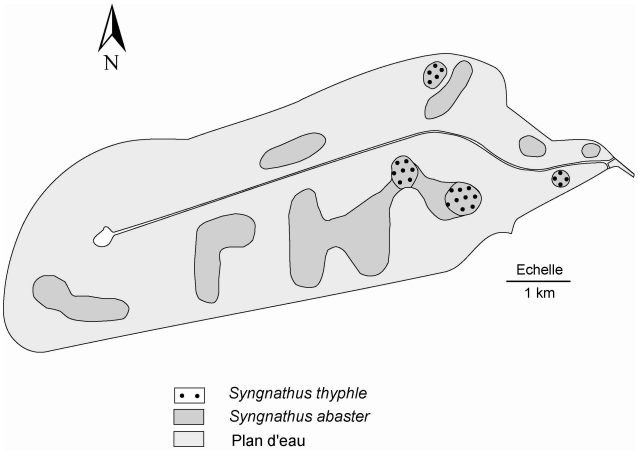


Fig. 1. Répartition spatiale de *Syngnathus abaster* et *Syngnathus typhle rondeleti* dans la lagune Nord de Tunis au printemps 2009.

References
1 - Shili A., 1995. Contribution à l'étude de *Ruppia* dans le Lac Nord de Tunis. Mémoire de Diplôme des Etudes Approfondies en biologie marine et océanographie, Faculté des Sciences de Tunis. 128p.
2 - Ben Maïz N., 1997. Le Lac Nord de Tunis : un milieu en mutation. In Gestion et conservation des zones humides tunisiennes. Actes de séminaire : 77-84.
3 - Chaibi K., Menif D., Mejri R. et Ben Hassine O.K., 2007. Première signalisation de *Nerophis ophidion* (Linnaeus, 1758) poisson syngnatide dans la lagune de Tunis, Tunisie. *Rapp. Comm. int. Mer Medit., 38 :447.*

PROBLEMATIC OF THE PELAGIA NOCTILUCA OUTBREAKS IN THE BAY OF CALVI (CORSICA)

J. Hecq [1]*, A. Goffart [1], A. Collignon [1], M. Garrido [2], P. Lejeune [3] and V. Pasqualini [2]
[1] Université de Liège- Océanologie, Centre MARE - jh.hecq@ulg.ac.be
[2] University of Corsica Pasquale Paoli, Corte (Corsica), France
[3] STARESO SA, Calvi (Corsica), France

Abstract

The interannual variations of the Schyphozoan jellyfish *Pelagia noctiluca* is estimated by weekly measurements in the Bay of Calvi (Corsica) from 2003. The mean annual abundance reaches a dramatic maximum in 2006. The medusae appear by migration of active swarms on the shelf and at the external limit of the Bay. Degraded individuals drift as passive swarms, throughout inner side of the Bay and embayments.

Keywords: Ligurian Sea, Zooplankton , Medusae, Coastal Systems, Time Series

The cyclic outbreaks of the holoplanktonic jellyfish *Pelagia noctiluca* have been extensively described in the Western Mediterranean, where the seasonal progression of the *P. noctiluca* blooms commences in late autumn- winter. High densities are maintained throughout the winter and the blooms end in the summer after a maximum of reproduction [1]. In the Ligurian Sea, P. noctiluca characterizes generally the offshore waters and develops actively at the level of the Liguro-Provençal Front [2].*P. noctiluca* develops in swarms, mostly observed at the level of the pycnocline and which can migrate to the surface [3]. The swarms occasionally drift to the shelf and seem to be regulated by macroscale hydrography and the hydroclimatic environment [4], local upwelling [5] or oscillations of Liguro-Provençal [6].

Actually, many processes related to the causality and dynamics of outbreaks remain unknown, especially those concerning swarm formation, migration and drift, at the scale of coastal embayment. In order to enhance our understanding of the factors controlling the dynamics of *P. noctiluca*, its abundance has been estimated weekly during 7 years (2003 - 2008) in the Bay of Calvi (Corsica) by visual observations, scuba diving and WP2 zooplankton sampling.

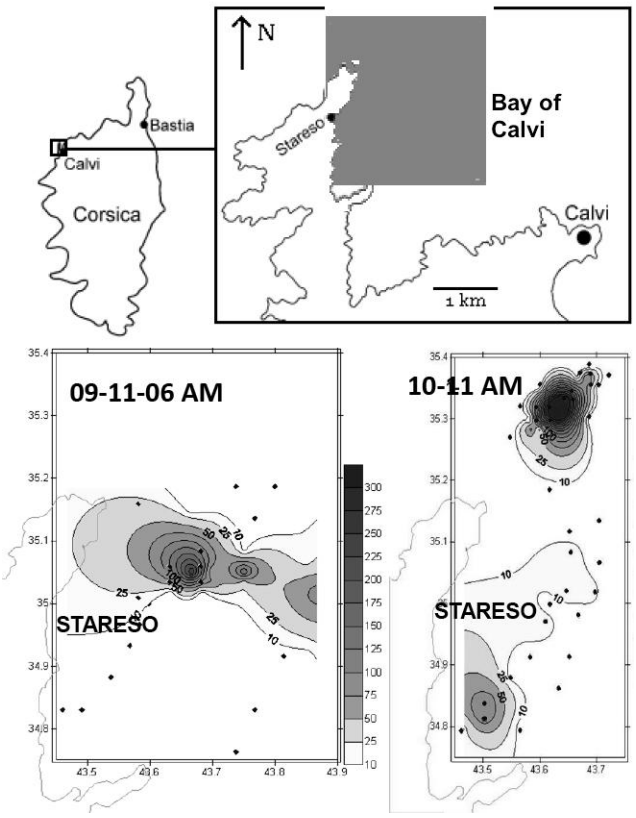


Fig. 1. Variation of a jellyfish *Pelagia noctiluca* swarm in the Bay of Calvi from 8 till 10 November 2006. Points represent the positions of counting by an onsurface diver. The concentrations express themselves in number of individuals counted on a radius of 10 m. Scale varies from 0 to 300 ind

The mean annual *P. noctiluca* abundance shows a progressive increase from 2004 to 2005 and reaches a dramatic maximum in 2006, followed by a progressive decrease during the summers 2007 and 2008. The *P. noctiluca* outbreaks start generally in late autumn-winter, maintain throughout the winter and disappear in spring. However, some years (e.g. 2005 to 2007), the seasonal progression continues during the late spring and large populations maintain during the summer. The outbreaks of *P.noctiluca* in 2006 could be correlated to the very intense mesozooplankton bloom in 2005

The distribution of swarms in the Bay of Calvi has been studied by scuba visual observations. Active swarms of 200 m of length and 50 m of wide appear on the shelf and at the external limit of the Bay by vertical migration, following some days of North-East (Fig.1). The swarms maintain in the same area for a few days. In these active swarms, 5 to 10 *P. noctiluca* per m³ were observed between 10 to 60 meters depth. The individuals were equidistant, swimming actively with the extended tentacles and capturing the food. In certain cases, individuals partially destroyed, dying or at the end of their biological cycle, escape from active swarms and derive passively in the first meters of the water column towards the coastal zones and embayments under the effect of the wind and the movements of the water. The degraded individuals which have lost tentacles or manubrium, move slowly and accumulate in large number (sometimes more than 200 m^{-2}), edge to edge, in passive patches limited to the first three meters of water column. These swarms undergo an active predation by numerous sparid fishes. They disappear in a few hours, reduced by this predation or by massive sedimentation of the dead animals.

Acknowledgments: The study was done in the programme MEDUSE granted by the Agence Française de l'Eau (Rhone- Méditerranée- Corse). We thank Sylvain Plazza and the STARESO staff for sampling operations. JH Hecq is Senior research associate to the FRS-FNRS (Belgium).

References

1 - Licandro P., Daly Yahia M.N., Fernandez de Puelles M.L., Gasparini S., Hecq J.-H., Tranter P. and Kirby R.R. Spatial and temporal extent of a blooming jellyfish in the Northeast Atlantic and Mediterranean Sea. Submitted to *Biological Letters.*

2 - Morand P., Goy J. et Dallot S., 1992. Recrutement et fluctuations à long-terme de *Pelagia noctiluca* (cnidaria, scyphozoa), *Annales de l'Institut Océanographique*, 68(1-2):151-158.

3 - Malej A., 1989. Behaviour and trophic ecology of the jellyfish *Pelagia noctiluca* (Forsskil, 1775). *J. exp. mar. Biol. Ecol.*, 126: 259-270.

4 - Zavodnik D.,1987. Spatial aggregations of the swarming jellyfish *Pelagia noctiluca* (Scyphozoa). *Mar. Biol.* 94(2):265-269.

5 - Skliris N., Goffart A., Hecq J.H. and Djenidi S, 2001. Shelf-slope exchanges associated with a steep submarine canyon off Calvi (Corsica, NW Mediterranean Sea): A modelling approach. *Journal of Geophysical Research*, 106 (C9) : 19883-19902.

6 - Goffart A., Hecq J.H. et Prieur L.,1995. Contrôle de la distribution du plancton par le front Liguro-provençal (secteur corse): Evolution saisonière et variabilité interannuelle. *Oceanologica Acta*, 18(3): 329-342.

ASSESSING THE IMPACT OF FISHING AND PROTECTION ON THE DYNAMICS OF THE SEA BREAM POPULATION IN THE NORTH-WESTERN MEDITERRANEAN SEA USING A SIMULATION MODEL

Chirine Hussein [1]*, Marion Verdoit-jarraya [1] and Philippe Lenfant [1]
[1] Postre - chirine.hussein@voila.fr

Abstract

We used ISIS-fish model to evaluate the impact of spatial and seasonal management measures on the dynamics of the sea bream population *Diplodus sargus sargus* (L., 1758) of the French Catalan fishery (North-Western Mediterranean). First, in order to identify the most significant parameters of model, a sensitivity analysis were carried out according to a fractional factorial experimental design. The method used consists in modifying some input parameters of the model by ± 20% around its initial value. Second, we attempted to disentangle the effects of several measures jointly implemented; as marine protected areas MPAs, changes in gillnet mesh size and fishing effort reduction.

Keywords: Biodiversity, Coastal Management

Introduction

Over-exploitation of marine fisheries resources remains a serious problem worldwide. The traditional management measures (quotas, limiting fishing effort, size minimum capture) does not ensure the sustainability of fisheries [1], marine protected areas MPAs have been strongly advocated as an ideal tool and a central element of many marine resource management plans. In the study area, the legislative framework focused on marine protected areas (Cèrbère-Banyuls reserve) and on the minimum landing size. In the present paper, our interest is twofold. First, study the influence of uncertainty model on a sensitivity analysis, which is to identify, quantify and analyze how to react exits from one model to disturbances on the variable entry. Second, we present the results of the simulation numeric to assess quantitatively the impact of various management measures of fishing and protection on the sea bream population.

Materials and methods

In this paper, we used ISIS- fish model to evaluate the impact of spatial and seasonal management measures on the dynamics of the sea bream population *Diplodus. Sargus Sargus*, of the French Catalan fishery . In our model, numerous parameters are fixed as they present a range of variation. This is the case of the fecundity rate [2], recruitment [3], growth [2], [4], catchability [5], mortality [6]. Then, uncertain parameters were identified and grouped into 9 groups: length range, fecundity coefficients, migration coefficients, natural mortality, catchability coefficients, gears standardisation factors, target factors and the number of inactivity days for each strategy. Analysing the effect of several parameters simultaneously makes it possible both to show their possible interactions and to rank them according to their importance of the model. The method used consists in modifying each input parameter of the model by ± 20% around its initial value. The effect of each operated modification is analysed on 5 outputs of the model (biomass at the last time step. last year catches, five last year's cumulative catches, last year nominal effort and five last year's cumulative nominal effort).

Results

The outputs considered showed particularly sensitive to some parameters such as natural mortality, length stage, gears standardisation factors, fecundity and catchability coefficients. Various management measures of commercial and recreational fisheries were simulated during 10 years in order to evaluate potential impact of fishing and to reduce over exploitation of the fishery, including for example, the imposition of AMPs in the nursery areas and in the spawning areas. An increase in gillnet minimum mesh size, from 60 to 80 mm were adopted to improve gear selectivity in the groundfish fishery. Finally, we attempts to reduce effort by 50% during the 5 first years and during the simulation duration. According to our model assumptions, the fishery has been overfished. In the model simulations carried out to explore the impact of possible management intervention:(a) MPAs nursery zones which would be an alternative management tool for conserving marine resources and ecosystems, (b) a change in the minimum mesh size to 80mm would cause an increase of 33% in the total catch (kg) and 51% in the gillnet catch in the long term, and (c) Limiting the fishing effort current levels resulted in higher levels of biomass and catches for the fishery (from the current 779t. up to an average 1766t in the 10 year horizon: a 226.65% increase.

Discussion

Our study has evaluated a broad range of assumptions concerning the status of the area being protected (spawning ground and (or) nursery ground), and fishing selectivity. The experiments and analyses presented in this paper have clearly demonstrated the potentials for ISIS-Fish. This enabled us to carry out preliminary explorations the impacts of these measures and to make a general diagnosis about the significance of the impact and finally to group them with respect to the consequences on both biomasses and catches of sea bream population.Results of the analysis in two different areas of the no-take zone indicate that the seasonal closure (Jan.-Jun.) of the nursery zones is beneficial for fish stock recovery, thereby increasing the biomass of fishes , it will result in an about 50% increase of the total catch and an about 76% reduction of juvenile catches (about 25 t.). A change in the minimum mesh size to 80mm would cause an increase of 33% in the total catch (kg) and 51% in the gillnet catch in the long term, providing that the minimum landing size of sea bream was simultaneously raised from 23 cm to 23.65 cm. Limiting the fishing effort current levels resulted in higher levels of biomass and catches for the fishery where the stock size responses are likely to occur on two distinct time scales associated with growth of existing fish and future recruitment. In conclusion, in the present situation of existing management policy and with the knowledge currently available, we recommended a potential framework of a project aimed at evaluating the potential of a novel co-management approach adopted at the actual situation along the French Catalane coastline.

References

1 - Pauly D., Christensen V., Guénette S., Pitcher T.J., Sumaila U.R., Walters C.J., Watson R. and Zeller D., 2002. Towards sustainability in world fisheries. *Nature* 418: 689-695.

2 - Man-Wai, R., 1985. Les sars du Golfe du Lion. Thèse de doctorat, Université des Sciences et Techniques du Languedoc. 361pp.

3 - Planes, S., Macpherson, E., Biagi, F., Garcia-Rubies, A., Harmelin, J., Harmelin-Vivien, M., Jouvenel, J.-Y., Tunesi, L., Vigliola, L., Galzin, R., 1999. Spatio-temporal variability in growth of juvenile sparid fishes from the mediterranean littoral zone. *Journal of the Marine Biological Association of the United Kingdom* 79, 137-143.

4 - Mariani, S., 2005. Life-history- and ecosystem driven variation in composition and residence pattern of seabream species (Perciformes: Sparidae) in two Mediterranean coastal lagoons. *Marine pollution Bulletin*, in press.

5 - Pelletier, D., 1991. Les sources d'incertitudes en gestion des pêcheries, Evaluation et propagation des modèles, Institut National Agronomique Paris-Grignon, Paris.

6 - MacPherson, E., Biagi, F., Francour, P., Garcia-Rubies, A., Harmelin, J.G., Harmelin-Vivien M.L., Jouvenel, J.Y., Planes, S., Vigliola, L. and TunesiI, L., 1997. Mortality of juvenile fishes of the genus Diplodus in protected and unprotected areas in the western Mediterranean Sea. *Marine Ecology Progress Series* 160, 135-147.

SIGNATUS JAVUS, A NEW RECORD FROM THE SYRIAN WATERS, WITH A REFERENCE TO GROWTH & FEEDING OF TWO LESSEPSIAN FISH

A. Ibrahim [1]*, M. Lahlah [1], M. Y. Kassab [1], W. Ghanem [1] and S. Ogaily [1]
[1] High Institute of Marine Research, Tishreen University, Syria - a.ibrahim@aloola.sy

Abstract
One specimen of *Siganus javus* was caught during Oct. 2009 from the Syrian marine water. It is the first record in the Mediterranean Sea and may be a potential invader to the area. The study of feeding habits of two other lessepsian species from the Syrian waters revealed growth rates comparative to other local fish species and strong signs of starvation & food completions.
Keywords: Lessepsian migration, Competition, Growth

Introduction
Colonization of the eastern Mediterranean by Red Sea and indo-pacific species has started after Suez Canal opening in 1869 [1]. So far, fish species entered the Syrian water are mostly Lessepsian (42 species) and, to a lesser extent, western Med. migrants (14 species) [2], [3], [4], [5]. The family Siganidae in the eastern Med. is represented by two species, *S. luridus* & *S. rivulatus*, migrated through Suez Canal (CIESM 2002). Exotic fish are likely to influence the local fish community in many ways such as competition for food and space and the consequence effect on growth. Identifying the level & extent of such effects are important for the proper management measures. This paper presents the characteristics of a new lessepsian Siganids record and estimations of growth rates (for the age groups 1+ - 5+) and feeding habits (food composition, stomach fullness…) of two already established lessepsian fish species in the Syrian waters; Lizardfish, *Saurida undosquamis* and Squirrelfish, *Sargocentron rubrum*.

Results and Discussion
An Indo-Pacific originated fish species, Streaked spinefoot *Siganus javus* (L., 1766), was recorded for the first time in the Syrian waters and in the Mediterranean sea. It was captured on 10 Oct. 2009 by a trammel-net at night in a water depth of ≈20m above a rocky & muddy bottom facing to Lattakia port (N35 31 425 E35 44 893). Water properties (at 1m depth) were: Temperature (26.4°C), Oxygen conc. (5.14mg/l), Salinity (39.34), Turbidity (0.056) and Chlorophyll conc. (0.52µg/l).
The fish (Fig. 1) was identified and kept as a reference at the High Institute of Marine Research. The body is oval & compressed with 13 dorsal fin spines (preceded by a forward projecting 2.6mm spine); 10 dorsal soft rays; 7 anal spines, 9 anal soft rays; ventral (2 spines separated by 3 soft rays) and 16 pectoral soft rays. Its measurements (cm) are: total length 18.4, standard length 15.5, fork length 17.9, body depth 7.5, head length 3.9 and eye diameter 1.1.

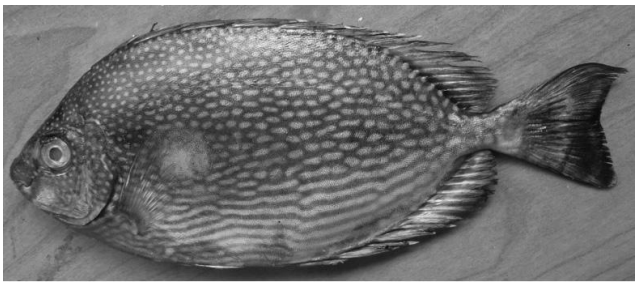


Fig. 1. *Siganus javus* from the Syrian waters

This species can be found in the Gulf of Oman, Pakistan, Thailand, southern China and down to Australia [6]. By recording this species, Siganidae would be represented by 3 species in the Syrian marine waters. However, this species is so far represented by a single specimen and its establishment has still to be proven and the introduction pathway has to be confirmed. To confirm the active migration, some future records in Suez Canal and in the south-eastern Med. sea are needed. Anyway, the survival in the Syrian waters and the recent sea warming make s. javus a potential eastern Med. invader.
Growth rate of the studied fish species was higher during the earlier life stages of life. Growth rate by length (cm) of *Sargocentron rubrum* for example was 5.5, 4.6, 2.2, 2.1 and 1.9 cm/y for the 5 age groups respectively. These estimations are comparative with other existing species such as *Pagrus coeruleostictus* and *Sardinella aurita.* The food of the Lizardfish consisted mostly of fish (mainly *S. aurata* & *B. boops* (and that of the Squirrelfish was of Crustacea (maily Amphipoda, Isopoda and Decapoda). Both fish species had a clear food competition with many coexisting fishes. Stomach fullness rarely exceeded 50%; indicating that both fish species do not feed well in the study area.

Acknowledgement: The authors would like to thank Prof. Frederic Briand for his valuable help in the identification verification and tracking any previous records. Thanks also go to Mr. M. Shammat, whose fishing gears facilitated this work.

References
1 - Por, F.D., 1978. Lessepsian migration-the influx of Red Sea biota into Med. by way of the Suez Canal. Berlin: Springer, 228pp.
2 - CIESM, 2002. Atlas of exotic species in the Med. CIESM publication, Monaco, pp 254.
3 - Ibrahim A., Karroum M., and Lahlah M., 2002. Marine fish biodiversity of Syria: Nine new records. *J. Env. Res. Sust. Dev.*, Arab Uni. Union, 5: 68-93.
4 - Ghaliah M., 2002. A New record of fish migrating into the Syrian waters (eastern Med.) *Fistularia commersonii*. Tishreen Uni. Sci. J. 2002.
5 - Saad A., 2005. Bony Fish Collected from the Coast of Syria. *Turk. J. Fish. Aqu. Sci.* 5: 99-106.
6 - Woodland, D.J., 1990. Revision of the fish family Siganidae with descriptions of two new species and comments on distribution and biology. Indo-Pacific Fishes (19):136 p.

INVASIVE HOST, *CHARYBDIS LONGICOLLIS* (DECAPODA: BRACHYURA: PORTUNIDAE), AND INVASIVE PARASITE, *HETEROSACCUS DOLLFUSI* (CIRRIPEDIA: RHIZOCEPHALA: SACCULINIDAE)

Gianna Innocenti [1]* and Bella S. Galil [2]

[1] Museo di Storia Naturale, Sezione di Zoologia "La Specola", Università di Firenze - gianna.innocenti@unifi.it

[2] National Institute of Oceanography, Israel Oceanographic and Limnological Research, P.O. Box 8030, Haifa 31080, Israel

Abstract

The Levantine populations of Erythrean invasive swimming crab *Charybdis longicollis* have been parasitized by the rhizocephalan *Heterosaccus dollfusi*, itself an Erythrean alien, since 1992. The parasite affects the host morphology, moulting, behaviour, causes its sterilization, and induces mortality. The high prevalence of *H. dollfusi* can be ascribed to the dense population of the host, the year-round reproduction of the parasite that promotes recurrent re-infection. Despite the high prevalence of the parasite and its injurious impact on the host reproduction, the invasive host-parasite pair has reached an apparent *modus vivendi*.

Keywords: Levantine Basin, Decapoda, Parasitism

Instances of rhizocephalans accompanying their invasive hosts are few. Yet among the hundreds of alien species that have entered the Mediterranean through the Suez Canal such an invasive host-parasite pair was identified: the portunid crab *Charybdis longicollis* (Fig. 1) with its parasitic barnacle *Heterosaccus dollfusi* (Fig.2).



Fig. 1. A male specimen of *Charybdis longicollis* Leene, 1938.

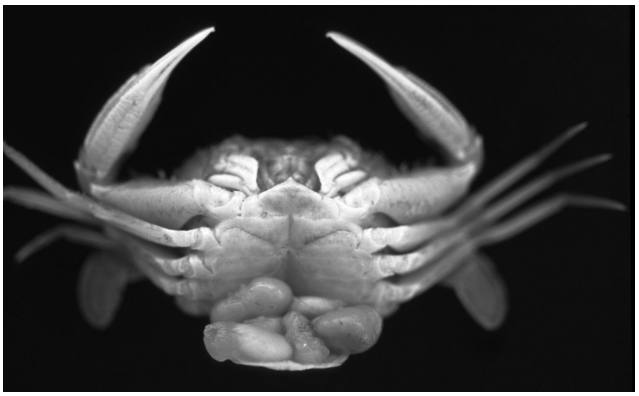


Fig. 2. *Charybdis longicollis* parasitized by 6 externa of *Heterosaccus dollfusi* Boschma, 1960.

A significant percentage of the host population along the Levant coast has been parasitized [1]. The parasite causes sterilization, morphological and behavioral feminization, cessation of molting and by placing high energetic demands on the host, induces mortality [2], [3]. Aspects of the biology, ethology and population dynamics of the invasive host-parasite pair along the Mediterranean coast of Israel have been studied since 1992. Nearly 19,000 crabs were examined, among these, over 10,000 were either externae-bearing, or internally-parasitized morphologically-modified crabs. The incidence of parasitization has been high and fairly stable over the past 15 years. The number of specimens and the incidence of parasitizationwere higher in the spring (May-June) than in the fall samples (August-October). The abdomen of both sexes of infected C. *longicollis* is modified to such an extent that the sexual apertures remain the only reliable character. Infection of the females causes the loss of the swimmerets, whereas in males the copulatory appendages are lost or reduced, and the abdomen broadens to such a degree that it closely resembles that of an uninfected female. In post-parasitization host populations the average and maximal size of non-parasitized males is larger than parasitized males whereas average and maximal size of non-parasitized female crabs are smaller than those bearing externa. It is proposed that *H. dollfusi* mayregulate the female host size to best endure the significant metabolic costs of the reproductive externa. Modifications of grooming, burying, courtship and mating, and agonistic behaviour have been observed in parasitized *C. longicollis*. The feminized agonistic behavior of male crabs parallels the feminization of the secondary sex characters and size range of *H. dollfusi*-parasitized*C. longicollis* (see above). It is also suggested that the presence of the parasite reduces belligerence in male crabs, enhancing injury avoidance [4]. Multiple parasitization has been common: nearly 40% of the externae-bearing hosts sampled between 1994 and 2009 harboured more than one externa, and over 17% bore three externae or more. The percentage of specimens bearing three or more externae is five times as high in spring as in fall samples. The pattern that emerges from the examination of the percentage of externae-bearing hosts bearing more than a single externa is that it increases when the incidence of parasitization rises above 50%.Almost without exception multiple externae occur among smaller crabs, presumably because they survive more poorly than single parasites. By placing an unacceptably high nutritional demand on the host, multiple externae weaken it and in many cases cause its untimely death.

References

1 - Innocenti G. and Galil B.S., 2007. *Modus vivendi*: invasive host/parasite relations - *Charybdis longicollis* Leene, 1938 (Brachyura: Portunidae) and *Heterosaccus dollfusi* Boschma, 1960 (Rhizocephala: Sacculinidae). *Hydrobiol.*, 590: 95-101.

2 - Galil B.S. and Lützen J., 1995. Biological observations on *Heterosaccus dollfusi* Boschma (Cirripedia: Rhizocephala), a parasite of *Charybdis longicollis* Leene (Decapoda: Brachyura), a lessepsian migrant to the Mediterranean. *J. Crust. Biol.*, 15: 659-670.

3 - Innocenti G., Vannini M. and Galil B.S., 1998. Notes on the behaviour of the portunid crab *Charybdis longicollis* Leene parasitized by the rhizocephalan *Heterosaccus dollfusi* Boschma. *J. Nat. Hist.*, 32: 1577-1585.

4 - Innocenti G., Pinter N. and Galil B.S., 2003. Observations on the agonistic behavior of the swimming crab *Charybdis longicollis* Leene infected by the rhizocephalan barnacle *Heterosaccus dollfusi* Boschma. *Canad. J. Zool*., 81: 173-176.

ON THE PREVALENCE OF AN ALIEN RHIZOCEPHALAN PARASITE AT THE SOUTHERN AND NORTHERN LIMITS OF ITS INTRODUCED RANGE

G. Innocenti [1]*, B. Galil [2], M. Yokes [3], A. Diamant [4] and M. Goren [5]

[1] Museo di Storia Naturale, Sezione di Zoologia "La Specola", Università di Firenze - gianna.innocenti@unifi.it

[2] National Institute of Oceanography, Israel Oceanographic & Limnological Research, P.O. Box 8030, Haifa 31080, Israel

[3] Halic University, Department of Molecular Biology & Genetics, Ahmet Vefik Pasa Cd. No:1 Findikzade, Istanbul 34093, Turkey

[4] National Center for Mariculture, Israel Oceanographic and Limnological Research P.O.B. 1212, Eilat 88112, Israel

[5] Department of Zoology, George S. Wise Faculty of Life Sciences, Tel Aviv University, Tel Aviv 69978, Israel

Abstract

The Erythrean crab *Charybdis longicollis* had established populations in the Levantine basin of the Mediterranean Sea in the mid 20th century, that were parasitized, in the last decade of that century, by the rhizocephalan *Heterosaccus dollfusi*, itself an Erythrean alien. In May 2008 the host populations were sampled at the southern (Israel) and northern (Turkey) limits of its introduced range. The prevalence of infection and multiple externae-bearing hosts were higher in Israel than in Turkey. It seems that off the Israeli coast the water temperature permits the synchronous ontogenetic development of both host and parasite ensuring availability of plentiful young, recently-molted prospective hosts for infection by the short-lived parasite cypris.

Keywords: Crustacea, Temperature, Parasitism

Absence of natural enemies, be it competitors, predators, or parasites, is one of the explanations given for the success of alien biota. Yet, though parasite species richness may be lower in alien hosts in their new range, the prevalence of infection may be many times higher. The Levantine populations of the Erythrean invasive swimming crab *Charybdis longicollis* have been parasitized by the sacculinid rhizocephalan *Heterosaccus dollfusi*, itself an Erythrean alien [1]. An earlier study that examined the temporal variability of *H. dollfusi* prevalence at Palmahim, Israel, a site at the southern end of its introduced range, found that despite the high prevalence of the parasite and its injurious impact on the host, there was "no noticeable reduction in the host population"[2]. We sought to examine the spatial variability of the parasite's prevalence along a latitudinal gradient within its introduced range. To that end we sampled the host populations off Ashdod (Israel) and
Antalya (Turkey) in May 2008 and July 2009.



Fig. 1. Map of the investigated area: *=Antalya, **=Ashdod.

The prevalence of infection in Ashdod was more than three times higher than in Antalya. Multiple parasitization was common in the Ashdod population of *C. longicollis*: over half of the externae-bearing hosts harboured more than one externa. In contrast, most of the externae-bearing hosts (84.2%) collected off Antalya bore a single externa, and only few more than three. Multiple externae are related to prevalence of infestation, as the parasite avoids settling on an already infected host, and does so only when the chances of encountering an uninfected host are diminished. The small number of externae-bearing hosts bearing more than a single externa off Antalya (15.8%), though the density of the host population is high, is further proof that the infection rate off Antalya is indeed a fraction of that in Ashdod and not a fortuity of the sampling.

Antalya					Ashdod				
	May 2008		July 2009			May 2008		July 2009	
	N	%	N	%		N	%	N	%
M	481	*51.0*	673	*59.6*	M	234	*14.9*	150	*23.9*
F	280	*29.7*	215	*19.0*	F	136	*8.7*	320	*33.1*
MI	20	*2.1*	109	*9.6*	MI	843	*53.7*	239	*5.1*
ME	82	*8.7*	66	*5.8*	ME	239	*15.2*	375	*19.5*
FI	11	*1.2*	20	*1.8*	FI	34	*2.2*	86	*3.4*
FE	70	*7.4*	47	*4.2*	FE	83	*5.3*	288	*14.9*
tot	***944***		***1130***		tot	***1569***		***1458***	
parasite ratio	***19.4***		***21.4***		parasite ratio	***76.4***		***67.8***	
	May 2008		July 2009			May 2008		July 2009	
	average CW	range	average CW	range		aver. CW	range	aver. CW	range
M	41.8	21.6-63.5	39.5	21.2-59.0	M	28.2	17.0-59.7	34.4	25.7-52.5
F	34.8	24.6-46.7	33.1	23.8-44.7	F	27.1	19.4-40.6	29.4	24.5-38.6
MI	34.3	27.1-53.4	31.3	21.2-44.8	MI	26.6	15.0-42.2	32.7	21.1-46.0
ME	36.7	26.3-54.7	38.8	30.6-56.0	ME	30.5	20.2-43.3	34.8	26.0-47.1
FI	30.3	25.3-39.0	34.2	28.8-44.3	FI	29.9	21.7-38.1	33.2	27.1-39.7
FE	36.0	25.8-43.9	37.3	28.0-47.8	FE	31.0	20.1-40.9	33.1	24.0-46.2

Fig. 2. Incidence of parasitization and carapace width (mm) in *Charybdis longicollis* respectively collected off Antalya, Turkey, and Ashdod, Israel, in May 2008 and July 2009. M, F: unparasitized males and females, MI, FI: internally parasitized males and females, ME, FE: externa-bearing males and females.

What then could constrain the parasitization of *C. longicollis* in the northern part of its introduced range? Could it be a biological response of a thermophilic alien to a latitudinal gradient of temperature? Data from the population off the Israeli coast suggest that this critical stage takes place in spring. Off the Israeli coast the water temperature permits the synchronous ontogenetic development of both host and parasite ensuring availability of plentiful young, recently-molted prospective hosts to the short-lived parasite cypris. The lower water temperature off Antalya may affect the timing of ontogenetic stages of one or the other, or increase the mortality of infected hosts, resulting in a sharply reduced infection success.

References

1 - Galil B.S. and Lützen J., 1995. Biological observations on *Heterosaccus dolfusi* Boschma (Cirripedia, Rhizocephala), a parasite of *Charybdis longicollis* Leene (Decapoda: Brachyura), a lessepsian migrant to the Mediterranean. *J. Crust. Biol.*, 15: 659–670.

2 - Innocenti G. and Galil B.S., 2007. Modus vivendi: invasive host/parasite relations - *Charybdis longicollis* Leene, 1938 (Brachyura: Portunidae) and *Heterosaccus dolfusi* Boschma, 1960 (Rhizocephala: Sacculinidae). *Hydrobiol.*, 590: 95–101.

ZOOPLANKTON COMMUNITY STATE IN THE ADJACENT REGIONS OF THE BLACK AND MARMARA SEAS

Melek Isinibilir [1]*, Leonid Svetlichny [2] and Elena Hubareva [2]
[1] Istanbul University, Faculty of Fisheries - melekisinibilir@hotmail.com
[2] Institute of Biology of the Southern Seas, Sevastopol, Ukraine

Abstract
During 2005 -2008 species composition and abundance of mesozooplankton collected in the Bosphorus regions of the Black and Marmara Seas were studied taking into account the number of live and dead individuals. In the direction of the Marmara Sea from the Black Sea through the Bosphorus, the abundance of the Black Sea originated species reduced and the proportion of carcasses increased. On the contrary, the abundance of the Mediterranean species diminished toward the Black Sea. High number of their carcasses was found in the Black Sea near the Bosphorus.
Keywords: Zooplankton , Mortality, Black Sea, Marmara Sea

The Black and Marmara Seas are connected with the narrow Bosphorus Strait (31 km). Due to positive water balance in the Black Sea, its water masses are transferred into the Marmara Sea through the Bosphorus forming a brackish surface layer (15-20 m) with a salinity of 18-24 ‰ and temperature ranging from 20-24 ^{0}C in summer to 8-9 ^{0}C in winter. Below this brackish layer lies more densely saline (about 39 ‰) Mediterranean Sea water with a constant temperature of about 15 ^{0}C throughout the year. These dense and warm water masses enter from the Bosphorus with deep countercurrent and mix with overlying cold (6-8^{0}C) intermediate layer of the Black Sea. The aim of the study was to analyze spatial and vertical distribution of alive and dead components of mesozooplankton community in view of spatial and vertical structure of the water masses in the adjacent regions of the Black and Marmara Seas.

Zooplankton samples were collected with a closing Nansen net seasonally during 2005 – 2008 at the permanent stations in the Marmara Sea near the Prince Islands and Bosphorus, in the northernmost part of the Bosphorus Strait and in the Black Sea near the Bosphorus. The samples were preserved with 4% borax-buffered formaldehyde. In the laboratory species composition and numbers of individuals being alive before sampling and their carcasses with destructive changes in muscles and internal organs were determined under a dissecting microscope.

During all periods of the study the tendency to diminish from the Black Sea toward the Marmara Sea for abundance and biomass of the Black Sea originated zooplankton species was found. This trend was due to decrease in total abundance and biomass of mass Black Sea copepod. The mean annual biomass of the Black Sea copepods decreased from 3696.9±2008 mg.m^{-2} in the Black Sea to 832.8±453.9 mg.m^{-2} in the northern Bosphorus area and 329.8±265.7 mg.m^{-2} near the Prince Islands in the Marmara Sea. The abundance of dead organisms of the Black Sea origin increased toward the Marmara Sea. Maximum mortality of the Black Sea copepods was observed in the Bosphorus region of the Marmara Sea. In this area mean values of non-consumption mortality for the Black Sea copepods varied in limits of 8 – 60% increasing dramatically up to 80% in *Acartia clausi*. On the contrary, the mortality of Cladocera was low near the Bosphorus and reached 35% near the Prince Islands. In the Marmara Sea, the Black Sea species aggregate mainly in upper brackish or mixed layers whilst the Mediterranean organisms inhabit deep strata with high salinity. Usually the mortality in the Black Sea species increases with depth. In the northernmost part of the Bosphorus only 6 species of the Mediterranean origin were found. The main part of population of dominative *O. minuta* was attributed to the lower-layer flow where the mortality did not exceed 8 %, whereas in the upper layers the mortality of this species reached 42 %.

According to [1] and [2], mass mortality of copepods penetrating into the Marmara Sea from the Black Sea is connected with low tolerance to sharp salinity increase in the intermediate layer of the Marmara Sea. High mortality of warm-water Mediterranean species transferred to the Black Sea with the Bosphorus deep countercurrent may be due to both low salinity and temperature of their new environment.

Acknowledgements: This study was supported by both TUBITAK-NASU joint projects (107Y208) and NATO Linkage Grant (EST.NUKR.CLG 983036).

References
1 - Svetlichny L.S, Hubareva E.S., Kideys A.E., Isinibilir M. and Shmeleva, A., 2006. Zooplankton community state in the Northeastern Marmara Sea during early autumn with comments on mass mortality of the Black Sea species due to the salinity gradient. *J. Black Sea / Mediterranean Environment*, 12: 213-231.

2 - Hubareva E.S., Svetlichny L., Kideys, A.E. and Isinibilir M., 2008. Fate of the Black Sea *Acartia clausi* and *Acartia tonsa* (Copepoda) penetrating into the Marmara Sea through the Bosphorus. *Estuarine, Coastal and Shelf Science*, 76: 131-140.

NON-DESTRUCTIVE DISTANCE SAMPLING SURVEYS FOR POPULATION DENSITY AND ABUNDANCE ESTIMATIONS OF BENTHIC FAUNA

Yiannis Issaris [1]* and Stelios Katsanevakis [1]

[1] Hellenic Centre of Marine Research, Institute of Marine Biological Resources - issaris@ath.hcmr.gr

Abstract

Conventional Underwater Visual Census (UVC) methods assume total detection of all individuals in the surveyed areas. However, when counting small taxa or cryptic species, this assumption is not usually met, leading to the underestimation of species abundance. Distance Sampling methods that account for the detectability of the animals surveyed have been applied successfully and are hereby proposed as efficient and unbiased tools for estimating the abundance of benthic species.

Keywords: Conservation, Monitoring, Sampling Methods

For estimations of population density and/or abundance of protected benthic species or surveys in protected habitats (e.g. seagrass beds, coral reefs), non-destructive methods are preferred than fisheries surveys. The most commonly used method in shallow waters is strip transect sampling with SCUBA diving. In strip transects, the observer travels along long narrow strips and records all animals of interest within the strip. The survey design comprises *k* randomly positioned strips or a grid of *k* systematically spaced strips randomly superimposed on the study area. Abundance in the study area *A* is estimated by where *n* is the number of detected individuals, A_c is ,the surface area covered by the survey, and P_c is the fraction of the study area that was covered by the survey (coverage probability).

$$\hat{N} = \frac{nA}{A_c} = \frac{n}{P_c}$$

In strip transect sampling, the critical assumption is that all individuals present in the surveyed areas are detected. However, this assumption cannot be tested using the survey data, and to ensure that it holds to a good approximation in all habitats and environmental conditions, it may be necessary to use narrow strips, which is problematic for scarce species and increases the variance of density estimators [1]. When designing a strip transect survey, there is no way to estimate the maximum strip width for certain detection of the target species. If the assumption that all individuals present in the surveyed areas are detected is not met, there is underestimation of abundance, which is not uncommon in underwater surveys especially when counting small taxa or cryptic species [2].

One of the most active areas of biometric and wildlife research is the development of methods and models to properly account for detection probability. One such widely used method that properly accounts for detection probability is distance sampling with line transects [1]. Distance sampling has been used extensively in terrestrial ecology and for marine mammals, as the standard method for abundance estimations of many species, but it has only rarely been used for underwater surveys of benthic fauna. In line transect sampling, a standardized survey is conducted along a series of lines searching for the animals of interest. For each animal detected, the distance from the line is recorded. The probability that any particular individual that is in the covered region is detected, i.e., the 'detection probability', is denoted by P_a. If *n* animals were detected in a distance sampling survey, then an estimation of the mean density and the total number of animals in the study area is given by

$\hat{D} = \frac{n}{A_c P_\alpha}$ and $\hat{N} = \frac{n}{P_c P_\alpha}$ respectively.

The main task of the analysis of distance sampling data is to estimate the detection probability P_a by the set of collected distances. This is done by modeling the detection function *g(y)*, i.e., the probability of detecting an individual that is at distance *y* from the line or point. Having estimated *g(y)*, the detection probability is given by $\hat{P}_\alpha = \frac{\int_0^w \hat{g}(y)dy}{w}$

The function *g(y)* is estimated from the distance data with a semi-parametric approach, as described in detail by Buckland et al. [1]. Detectability and the shape of the detection function in an underwater benthic survey may depend on various factors such as habitat type, water turbidity, weather conditions, sun position, the ability of the surveyor, the target species and its contrast, sex, or size. To illustrate how detectability may differ by species, four different species (the fan mussel *Pinna nobilis*, the Mediterranean scallop *Pecten jacobaeus*, the purple sea urchin *Sphaerechinus granularis*, and a sea cucumber *Holothuria sp*.) were surveyed with line transects in the same site (Lake Vouliagmeni, Greece) in the summer of 2004. Habitat, water conditions, and the observer were the same and thus the differences in the detection function may be mainly attributed to the species characteristics (Fig.1). We should note the key assumption in line transect sampling which is that all animals that are located on the line are detected with certainty, i.e., *g(0) = 1*. In practice, detection on or near the line should be nearly certain and survey design must consider ways to assure that this assumption is met [1]. However, when studying the populations of highly cryptic species, this assumption may be violated. In these cases, the imperfect detectability near the center line has to be properly accounted for. To achieve that, a mark-recapture distance sampling methodology has been developed [3].

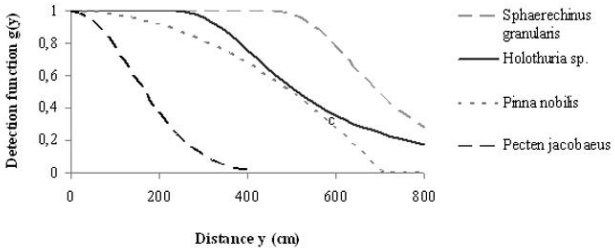


Fig. 1. Variability of the detection functions of four benthic species as estimated by surveys conducted with line transects

Under the mark-recapture distance sampling (MRDS) methodology, two independent observers undertake the counting of animals and the common detections are treated as recaptures. With this approach, *g(0)<1* is estimated and accounted for in the estimation of P_a. MRDS was applied to estimate abundance of a seahorse (Hippocampus guttulatus) population in a 34.5 hectares site of northeastern Korinthiakos Gulf, Greece. Twenty-eight line transects were surveyed under a stratified sampling scheme by two independent observers. The estimate of average seahorse detection probability, in transects of 4 m half-width, was 0.41 (Fig.2). Average population density (in individuals per hectare) was 42.9 (95% CI: 25.8– 71.3) and the estimated abundance in the study area was 1478 individuals (95% CI: 890–2455).

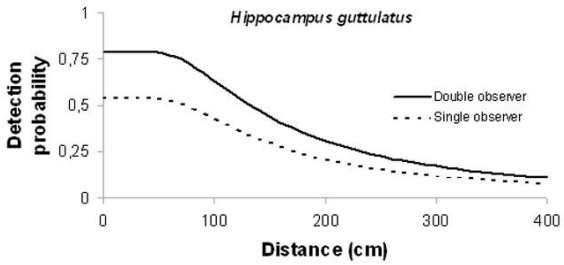


Fig. 2. Detection function of *Hippocampus guttulatus* using single and double observer data

References

1 - Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L., 2001. Introduction to distance sampling: Estimating abundance of biological populations. Oxford University Press, New York.

2 - Katsanevakis, S., 2006. Population ecology of the endangered fan mussel Pinna nobilis in a marine lake. *Endangered Species Research*, 1, 51-59.

3 - Laake, J.L. and Borchers, D.L., 2004. Methods for incomplete detection at distance zero. *In*: Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. (eds.), Advanced distance sampling: Estimating abundance of biological populations. Oxford University Press, New York, pp. 108-189.

IDENTIFYING DRIVERS OF ACCELERATING SEAGRASS LOSS IN THE MEDITERRANEAN: CAUSAL CHAIN AND SCENARIO ANALYSES

E. Jackson [1]*, O. Langmead [1], S. Fowell [1], M. Attrill [1] and L. Mee [2]
[1] Marine Institute, University of Plymouth - e.jackson@plymouth.ac.uk
[2] Scottish Association for Marine Science

Abstract
The primary causes of loss and degradation of Mediterranean seagrass beds were examined within a Driver Pressure State-Change Impact Response (DPSIR) framework as part of a larger EU project on European Lifestyles and Marine Ecosystems (ELME). Total losses were estimated at over 45 000 ha of seagrass over the last 100 years, with rates of change in the Mediterranean higher than recent global trajectories. Evidence gathered on the causes of loss (of seagrass habitat was used to produce Bayesian belief network (BBN) models to explore impacts of future changes in socio- economic drivers and policy.
Keywords: Posidonia, Coastal Management, Models

Introduction
Mediterranean seagrass meadows (primarily *Posidonia oceanica*) play a crucial role in stabilising sediments, maintaining water quality, protecting sedimentary shores from erosion and represent important fish production areas [1]. However, they are often disregarded during economic and social development, despite a wealth of studies illustrating declines due to anthropogenic pressures [2], and this trend is accelerating [3]. Including marine ecosystems components in policies for sustainable development requires a better understanding on the causal connections between human pressures (and their socio-economic drivers) and the changing state of the systems. This is particularly important at a time when the European Community is expanding, re-examining its agricultural and chemical policies, reforming its fisheries policy and exploring new ways to protect marine systems using an ecosystem-based approach (Marine Strategy Framework Directive). Here we assesses the causes of historical seagrass habitat loss in the Mediterranean and the evidence gathered is used to produce Bayesian belief network (BBN) models to explore the impact of plausible alternative human development scenarios on seagrass habitats.

Methods
The study presented here summarises the information on loss (dates, amount and causes) of seagrass habitat in the Mediterranean over the last 100 years. Data gathering was carried out via three main methods; searching published material, an online questionnaire and via direct contact with key organisations and experts. Results of metadata analyses were used to construct a BBN model of the Driver, Pressure and State-change pathways (using probability density functions derived from data to describe causal relationships between variables). The model was trialled under different scenario outcomes based on plausible future development patterns, policy options and likely social changes at European Community level. The scenarios employed in this study were designed to provide a general overview of alternative states of the world to highlight the differences that result from divergent pathways of socio-economic development [4]. A baseline scenario projecting future trends based on the current situation was contrasted with four Alternative Scenarios, defined at the extremes of two dimensions: governance and values. Each scenario comprises a description of the underlying values and policies that define it, and their broad socio-economic implications [5]. From these characterisations, narrative description of changes in basic socio-economic variables and activity in Driver sectors were developed for each scenario and translated into a simple categorical representation to indicate the direction of change in each of the Driver sectors, which were used to condition the BBN (full description see [6]).

Results and Discussion
We estimated total losses of over 45 000 ha of seagrass over the last 100 years, and identified rates seagrass loss for the Mediterranean which accede recent global trajectories. The causes of loss of seagrass habitat and the activities driving these pressures show patterns over time. The most numerically dominant activity causing past losses throughout the Mediterranean was input of urban sewage. However, there are indications that this activity pressure has been decreasing in frequency since the 1970s, perhaps due to improved wastewater treatment. The second most frequently observed pressure is from the fishing sector. There has been a gradually increasing trend in the loss of seagrass due to trawling, despite bans in the vicinity of seagrass beds in many parts of the Mediterranean. Other activities that are of growing concern are aquaculture (fish cages), tourism and shipping (anchoring, port construction). The BBN model (see Figure 1) was used to examine levels of seagrass loss and degradation under different combinations of pressures observed under different scenarios. Alarmingly under the baseline scenario (and assuming that there is full compliance to policy) the decline of *Posidonia* continues, despite improvements in urban wastewater treatment and a decline in the trawling and dredge fleet, mainly due to increases in finfish aquaculture and coastal urbanisation (affecting turbidity and organic matter enrichment). Continuing upward trends in livestock production and fertiliser carry on loading coastal systems with nutrients indirectly affecting the light received by *Posidonia*. Of the alternative scenarios only local responsibility leads to an improvement in *Posidonia* state, due to a steep decline in destructive fishing practices and a decrease in the drivers of nutrient enrichment and turbidity. National enterprise has devastating effects on the *Posidonia* with all of the major causes of seagrass loss and degradation showing an increasing trend or stabilising at current levels but not declining. The outputs of this study, in terms of transdisciplinary scenario models, are intended to provide scientific support for the implementation of the ecosystem approach in Europe.

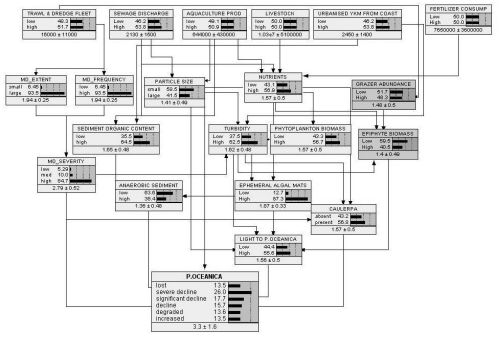


Fig. 1. Fully parameterised Bayesian Belief Network Model for *Posidonia oceanica* loss and degradation in the Mediterranean

References
1 - Procaccini, G., et al., 2003. The seagrasses of the Western Mediterranean, in World Atlas of Seagrasses, E.P. Green and F.T. Short, Editors. University of California: London. p. 48-58.
2 - Duarte, C.M., 2002. The future of seagrass meadows. *Environmental Conservation*, 29(2): p. 192-206.
3 - Waycott, M., et al., 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. p. 12377-12381.
4 - Cooper, P., Etherington, L., Bell, S., Farmer, A. & Williams, J., 2008. Socio-Economic Scenarios of European Development and Integrated Management of the Marine Environment. Working Paper Series 2008.08, University of Bath School of Management.
5 - Langmead, O., A. McQuatters-Gollop, and L.D. Mee., 2007. European Lifestyles and Marine Ecosystems: Exploring challenges for managing Europe's seas. University of Plymouth Marine Institute: Plymouth, UK. p. 43.
6 - Langmead, O., et al., 2009. Recovery or decline of the northwestern Black Sea: A societal choice revealed by socio-ecological modelling. *Ecological Modelling*, 220(21): p. 2927-2939.

INTERACTION DES TORTUES MARINES AVEC LES ENGINS DE PÊCHE DANS LE GOLFE DE GABÈS (TUNISIE)

Imed Jribi [1]*, Khaled Echwikhi [2], Abderrahmen Bouain [1] and Mohamed nejmeddine Bradai [2]
[1] Faculté des Sciences de Sfax, 3000, Tunisie - imed.jribi@fss.rnu.tn
[2] Institut National des Sciences et Technologie de la Mer ,3018, Sfax, Tunisie

Abstract
Le chalutage benthique, les palangriers (de fond et de surface) et les filets maillants engendrent des captures accidentelles de la tortue marine *Caretta caretta* dans le golfe de Gabès. Les taux de captures sont relativement importants induisant une mortalité souvent élevée. La mortalité induite par les filets maillants ciblant les requins est de loin la plus élevée.
Keywords: Mortality, Gulf Of Gabes, Turtles

Introduction
Les populations de tortues marines sont menacées d'extinction dans les différentes régions du monde. L'activité de pêche est considérée parmi les problèmes les plus menaçants et les plus urgents à résoudre pour assurer leur survie. Dans le golfe de Gabès, les tortues marines entrent en interaction avec la plupart des engins de pêche. Cette région, zone de pêche numéro 1 en Tunisie, est considérée par ailleurs comme une aire d'alimentation et d'hivernage des tortues marines en Méditerranée [1]. Ayant pour objectif la conservation, nous estimons dans ce travail les taux de capture et de mortalité des tortues marine par le chalut benthique, les palangriers de surface et de fond et les filets maillants côtiers opérant dans cette région.

Matériel et méthodes
Dans cette étude du golfe de Gabès, qui abrite environ 50% de la flottille de pêche du pays, nous avons réalisé 198 sorties en mer (73 avec des chalutiers, 80 avec des palangriers et 45 avec des embarcations côtières). Des observateurs à bord ont relevé les données suivantes : caractéristiques des engins de pêche, dates et heures, position géographique des opérations de pêche et des observations de tortues, espèce, Longueur Carapace Courbe (LCC), état physique de la tortue (vivante, morte, en coma). Les données sur les efforts de pêche déployés dans la région, fournies par l'administration des pêches, ont permis l'extrapolation des estimations des taux de capture et de mortalité des tortues à toute la flottille.

Résultats et discussion
Toutes les tortues marines, capturées accidentellement au cours de ce travail, étaient des caouannes *Caretta caretta*. Il s'agit, en effet, de l'espèce la plus abondante et qui nidifie sur certaines plages du pays. Les captures sont plus importantes dans les faibles profondeurs (en deçà de 50 m). Les tortues capturées sont essentiellement des juvéniles (LCC<70 cm). Les tailles moyennes des tortues capturées à la palangre de surface et au chalut benthique sont plus importantes que celles des tortues capturées à la palangre de fond (58,5 cm et 57,46 cm contre 48,7 cm). Le tableau 1 illustre les estimations des taux de captures et des mortalités directes (tortues trouvées mortes durant les opérations de pêche) pour les différents engins étudiés.

Engins de pêche	Espèces cibles	Taux de capture	Taux de mortalité
Chalut benthique	Crevettes et céphalopodes	0,006 t/l.d 0,822±0,249 t/sortie	3,33%
Palangre de surface	Requins et espadons	1,437±0,059 t/1000h 2±1,012 t/sortie	0%
Palangre de fond	mérous	0.633±0.040 t/1000h 1,142±0,79 t/sortie	12,5%
Filets maillants	requins	0.527±0.02 t/km²f.j 0.8±0.308 t/sortie	69,44%

t : tortue ; l.d : l est la longueur de la corde de dos du chalut/30,5m et d est la durée du trait de chalut/60mn ; h : hameçon ; f : filet et j : jour

Fig. 1. Taux de capture et de mortalité des tortues marines par les différents engins de pêche étudiés

Les taux de captures enregistrés sont relativement élevés et parmi les plus importants enregistrés en Méditerranée [2]. La mortalité est faible avec les chalutiers et les palangriers mais très élevée pour les filets maillants.

Conclusion
Les interactions de la caouanne avec l'activité de pêche dans le golfe de Gabès sont importantes. Cette espèce y est en effet relativement abondante et l'activité pêche y est également intense. L'atténuation du "by-catch" s'avère donc urgent dans cette région. La sensibilisation des pêcheurs, l'utilisation des "dehookers," l'essai d'hameçons circulaires, la manipulation adéquate à bord des tortues et la pêche plus au large, contribueraient à résoudre, en partie, le problème de ces interactions.

References
1 - Bradai M. N., Bentivegna F., Jribi I., El Ouaer A., Maatoug K. and El Abed A., 2005. Monitoring of a loggerhead sea turtle, *Caretta caretta*, in the central Mediterranean via satellite telemetry. *In* Demetropoulos A. and O. Turkozan (eds). 2009. Proceedings of the Second Mediterranean Conference on Marine Turtles. Barcelona Convention – Bern Convention – Bonn Convention (CMS). pp 54-57.
2 - Casale P., 2008. Incidental catch of marine turtles in the Mediterranean sea: Captures, mortality, priorities. WWF Italy, Rome. 67p.

RÉGIME ALIMENTAIRE DU POCHETEAU NOIR, *DIPTURUS OXYRINCHUS*, DANS LE GOLFE DE GABES (TUNISIE)

H. Kadri [1]*, S. Marouani [1], B. Saidi [1], A. Bouain [2] and M. N. Bradai [1]
[1] Institut National des Sciences et Technologies de la Mer, 802 – 3018 Sfax, Tunisie - hasnakadri@yahoo.fr
[2] Faculté des Sciences de Sfax. 802-3018, Tunisie

Abstract
Le régime alimentaire de *Dipturus oxyrinchus* a été étudié à partir des contenus stomacaux de 520 individus capturés dans le golfe de Gabès. Cette espèce se nourrit principalement de poissons téléostéens et de crustacés. D'autres invertébrés constituent toutefois des proies accessoires. Des variations dans le régime alimentaire ont été observées et sont liées à la taille et au sexe des individus.
Keywords: Food Webs, Elasmobranchii, Gulf Of Gabes

Introduction
Dipturus oxyrinchus est une espèce atlanto-méditerranéenne quasi-menacée en Méditerranée [1]. Aucune étude sur la biologie de cette raie n'a été fournie dans cette zone. Dans ce travail, nous contribuons à la connaissance du régime alimentaire de *D. oxyrinchus* dans le golfe de Gabès, selon des aspects quantitatif et qualitatif par l'analyse du coefficient de vacuité et de certains indices alimentaires.

Matériel et méthodes
Les contenus stomacaux de 520 individus (LT: 25 - 105 cm), capturés dans le golfe de Gabès entre septembre 2006 et juin 2008 ont été examinés. Pour chaque individu le sexe, la LT (cm) et l'état de réplétion (estomac vide ou plein) sont notés et les proies des estomacs pleins sont identifiées, dénombrées et pesées au 0.1 g prés. Le coefficient de vacuité (Cv%) a été analysé en fonction de la taille et des mois. L'aspect quantitatif du régime alimentaire a été décrit, l'indice de l'importance relative (IRI%) combinant les pourcentages d'occurrence (F%), numérique (N%) et pondérale (M%) a été déterminé pour évaluer l'importance relative des différents items alimentaires identifiés [2].

Résultats et Discussions
520 estomacs de *D. Oxyrinchus* ont été examinés. 87 estomacs étaient vides, soit un coefficient de vacuité de 16.7% indiquant la voracité de l'espèce. La période préférentielle d'alimentation se situe en automne et en hiver (Fig. 1). Ce coefficient ne varie pas significativement avec le sexe (P: 0.05), par contre il a une variation significative avec les tailles des individus (P: 0.05) ; ceci est probablement lié aux changements des besoins énergétiques et à la mise en place d'une stratégie de prédation plus élaborée chez les individus de grande taille. Le bol alimentaire (Tab. 1) montre que *D. oxyrinchus* a un large spectre alimentaire et un comportement de prédation aussi bien pélagique que benthique. L'importance pondérale ainsi que la fréquence des proies sont en faveur des Téléostéens. Numériquement, les crevettes sont les plus nombreuses alors que les taxons restant sont faiblement représentés. Les variations numériques et pondérales observées indiquent le caractère opportuniste du prédateur. Nos résultats corroborent avec ceux d'autres auteurs [3] qui soulignent que le régime alimentaire de *D. oxyrinchus* est surtout constitué de crustacés, téléostéens et des céphalopodes.

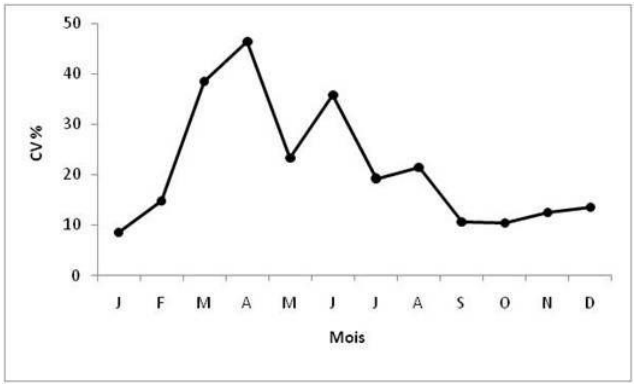


Fig. 1. Periode d'alimentation de la raie.

Tab. 1. Valeurs des différents indices alimentaires chez *Dipturus* oxyrinchus dans le golfe de Gabès

	F%	N%	M%	IRI%
Crustacés totaux	48.92	49	27.8	38.4
crevettes	45.6	45	22.9	29.5
Crabes	8.4	3.4	3.7	6.8
Crustaces non identifiés	1.5	0.6	1.2	2.1
Téléostens totaux	50.84	43.6	59.4	59
Sparidés	24.7	18.5	16.8	26
Serranidés	8.3	7.6	12.2	12.3
Carangidés	4.3	4.7	8.6	7.2
Clupeidés	3.86	3.6	6.3	3.2
Mullidés	2.17	2.7	3.8	2.7
Congridés	1.56	0.8	1.4	1.3
Téléostéens indéterminés	7.84	5.7	10.3	6.3
Cephalopodes	11.8	6.9	12.5	2.34
Gastéropodes	0.93	0.2	0.11	0.2
Polychetes	0.18	0.18	0.16	0.04
Echinodermes	0.07	0.12	0.03	0.02

References
1 - Cavanagh R.D. & C. Gibson., 2007. Aperçu du statut de conservation des poissons cartilagineux (Chondrichtyens) en mer Méditerranée. UICN, Gland, Suisse et Malaga, Espagne. vi + 39 pages.
2 - Pinkas, L. M.; Oliphant, S.; Iverson, I. L. K., 1971. Food habits of albacore, bluefin tuna, and bonito in Californian waters. *Calif. Fish Game* 152, 1–105.

DIVERSITY, STRUCTURE AND FUNCTION OF FISH ASSEMBLAGES ASSOCIATED WITH POSIDONIA OCEANICA MEADOWS IN EASTERN MEDITERRANEAN

S. Kalogirou [1]*, M. Corsini-Foka [2], A. Sioulas [2], H. Wennhage [1] and L. Pihl [1]
[1] Department of Marine Ecology Gothenburg University - skalogirou@hcmr.gr
[2] Hydrobiological Station of Rhodes - Hellenic Centre for Marine Research

Abstract
Temporal and spatial variation in density, biomass and size of littoral fish associated with *Posidonia oceanica* meadows were studied throughout an annual cycle. Approximately 109350 littoral fish were collected, belonging to 34 families and 88 species. Highest values of density were observed during August due to high densities of juveniles. Four functional guilds were created in order to describe the habitat use for each species encountered including juvenile migrants, seagrass residents, seasonal migrants and occasional visitors. Among the species encountered, eleven were found to be non-indigenous.
Keywords: Fishes, Posidonia, Aegean Sea, Levantine Basin, Biodiversity

Introduction
The ecological importance of *Posidonia oceanica* meadows, for the littoral zone of the Mediterranean, is from various aspects well sustained. *P. oceanica* meadows are highly productive and diverse communities and considered the high spot of soft bottom substrata [1]. They promote sediment stability [1], and their high complexity provides a habitat for food, shelter and nursery for several fish populations [4, 6]. This is the first study with the aim to quantitatively assess the fish assemblage associated with *Posidonia oceanica* meadows in eastern Mediterranean. We investigated the temporal and spatial dynamic, assemblage structure and functional guilds of the fish fauna. In addition, the role of newly and former non-indigenous species of Indo-Pacific origin was studied in this habitat.

Materials and Methods
In order to study temporal and spatial variations in fish assemblages, day samples were taken at five shallow (5-35 m) locations around the coasts of Rhodes Island with boat seining on four occasions over the year 2008: February (winter), May (spring), August (summer) and December (autumn). Fish species density, biomass and average size was seasonally recorded during an annual cycle and used to create functional groups. The functional guilds defined in this study consisted of similar to those described by Elliot and Dewailly [3], although modified depending on own data and observations. The definitions we use here are: SR – Truly seagrass residents, species which are stationary on *Posidonia oceanica* meadows and are highly dependent on them; JM – juvenile migrants, species which use seagrasses primarily as a nursery ground, but often returns as adults for spawning or feeding; SM – seasonal migrants, species which have seasonal visits to seagrasses, usually as adults for spawning or feeding and OV – occasional visitors, species that appear irregularly on seagrasses but have no apparent seagrass requirements.

Results
Our study showed that *Posidonia oceanica* meadows from eastern Mediterranean sustain a diverse fish community including 88 species within 34 families a number that accounts for 19% of the total number of species inhabiting eastern Mediterranean [7, 5). Density showed significant seasonal seasonal differences ($p<0.01$) which was as revealed from Tukey's HSD attributed to significant higher values during summer compared to all other seasons ($p<0.01$). Mean fish density showed approximately three times higher values in summer compared to any other season, while species richness showed slightly higher average values in spring and summer. Native planktivorous school forming species (e.g. *B. boops*, *S. smaris*, *S. maena*, *C. chromis*), were dominant in terms of abundance. Labridae and Sparidae families were found to be the two most diverse fish families, which is in accordance to previous studies from western Mediterranean [1, 2, 4]. The fish assemblage consisted of 24 seagrass resident, 17 juvenile migrants, two seasonal migrants and 45 occasional visitor species.Several species within seagrass resident guild were of commercial value (e.g. *Spicara smaris*, *Spicara maena*) and showed high contribution to total abundance (Table 1). Several species in the juvenile migrant guild were of commercial importance (Table 1). Most of the species within the diverse and dominating family Sparidae, were classified as juvenile migrants, indicating a habitat use mainly during their early life stages.

Tab. 1. Ranking of the 10 dominant species in terms of total biomass and density on *P. oceanica* meadows. Family, origin and ecological guild are indicated. * denotes species of commercial value

Rank	Species	Family	Origin	Ecological guild	Biomass (kg)
1	*Boops boops**	Sparidae	I	SR	527·69
2	*Spicara smaris**	Centracanthidae	I	SR	231·75
3	*Chromis chromis*	Pomacentridae	I	SM	148·48
4	*Spicara maena**	Centracanthidae	I	SR	80·62
5	*Oblada melanura**	Sparidae	I	JM	33·41
6	*Sphyraena viridensis**	Sphyraenidae	I	SR	32·79
7	*Lagocephalus sceleratus*	Tetraodontidae	NI	SR	27·27
8	*Sparisoma cretense**	Scaridae	I	JM	22·08
9	*Coris julis*	Labridae	I	SR	16·78
10	*Pagrus pagrus**	Sparidae	I	JM	12·17

	Species	Family	Origin	Ecological guild	Density
1	*Spicara smaris**	Centracanthidae	I	SR	40056
2	*Boops boops**	Sparidae	I	SR	31202
3	*Chromis chromis**	Pomacentridae	I	SM	16646
4	*Sardina pilchardus**	Clupeidae	I	JM	2845
5	*Spicara maena**	Centracanthidae	I	SR	2148
6	*Coris julis*	Labridae	I	SR	2103
7	*Siganus rivulatus**	Siganidae	NI	JM	2055
8	*Sphyraena chrysotaenia**	Sphyraenidae	NI	JM	1325
9	*Mullus surmuletus**	Mullidae	I	JM	1312
10	*Sparisoma cretense**	Scaridae	I	JM	1077

Discussion
Seagrass resident species were widely represented within the dominant families of the fish assemblage (e.g. Centracanthidae, Labridae, Mullidae, Sphyraenidae and Syngnathidae). All juvenile migrants were found to use seagrass meadows during samplings in August and usually occurred in high densities. Spring was found to be the main season in seagrass for *Chromis chromis* and *Thalassoma pavo*, and due to their occurrence only as reproductive adults, they were classified as seasonal migrants.

References
1 - Bell, J. D. & Harmelin-Vivien, M. I., 1982. Fish fauna of French Mediterranean *Posidonia oceanica* seagrass meadows. 1. Community structure. *Tethys* 10, 337-347.
2 - Deudero, S., Morey, G., Frau, A., Moranta, J. & Moreno, I., 2008. Temporal trends of littoral fishes at deep Posidonia oceanica seagrass meadows in a temperate coastal zone. *Journal of Marine Systems* 70, 182-195.
3 - Elliott, M. & Dewailly, F., 1995. The structure and components of European estuarine fish assemblahes. *Netherlands Journal of Aquatic Ecology* 29, 397-417.
4 - Francour, P., 1997. Fish Assemblages of Posidonia oceanica Beds at Port-Cros (France, NW Mediterranean): Assessment of Composition and Long-Term Fluctuations by Visual Census. *Marine Ecology* 18, 157-173.
5 - Golani, D., Öztürk, B. & Basusta, N., 2006. The Fishes of Eastern Mediterranean. Istanbul: Turkish Marine Research Foundation.
6 - Guidetti, P., 2000. Differences Among Fish Assemblages Associated with Nearshore Posidonia oceanica Seagrass Beds, Rocky-algal Reefs and Unvegetated Sand Habitats in the Adriatic Sea. *Estuarine, Coastal and Shelf Science* 50, 515-529.
7 - Papakonstantinou, C., 1988. *Check* - list of marine fishes of Greece Athens: National Centre for Marine Research - Hellenic Zoological Society.

FOOD AND FEEDING HABITS OF NINE ELASMOBRANCH SPECIES IN THE N AEGEAN SEA

Paraskevi k Karachle [1]* and Konstantinos i Stergiou [1]
[1] Aristotle University of Thessaloniki, School of Biology, Department of Zoology, Lab of Ichthyology - pkarachl@bio.auth.gr

Abstract
We present diet composition for nine elasmobranch species the N Aegean Sea. These species fed mainly on Crustacea, Cephalopoda and fishes, and to a lesser extent on Polychaeta. Based on their feeding habits, they form two distinct groups: one including species with streamline body shape and *Raja miraletus* and the other one all the remaining dorso-ventral flattened species.
Keywords: Elasmobranchii, Diet, Aegean Sea

Introduction
In this study we present the feeding habits of nine elasmobranch species from the N Aegean Sea. Out of those nine species information from the Aegean Sea exist only for four species (i.e. Dasyatis pastinaca [1]; Raja clavata [2]; Raja radula [3]; and Scyliorhinus canicula [2]). These data are useful for studying the Mediterranean marine food webs and developing local ecosystem models.

Materials and Methods
Seasonal samples (spring 2001-winter 2006) were collected, using commercial fishing vessels (for a detailed account on samplings see [4]). Diet data were analysed with multivariate analyses ([5]) in order to identify groups of species with similar diets. Additionally, SIMPER analysis [5] was employed to identify food items responsible for group formation.

Results and Discussion
Overall, the stomach content of 172 individuals, belonging to 9 different elasmobranch species were examined (Table 1). The small number of individuals is attributed to the fact that many of these species are rare in the study area, or were caught in low abundances with the fishing gears used. Dalatias licha, Galeus melastomus and Scyliorhinus canicula fed mainly on Cephalopoda (97.3, 93.6 and 50.2%, respectively), T. marmorata on fish (99.3%), whereas all the remaining species preyed mainly on Crustacea (Dasyatis pastinaca: 74.6; Dipturus oxyrhinchus: 100.0; Raja clavata: 63.7; Raja miraletus: 68.7; and Raja radula: 53.3%) (Table 1). The diets of the species in the present study were similar to those reported from other areas ([1], [2], [3], [6]), except for D. oxyrinchus. The latter preys mainly upon fish [6], whereas in the present study we only caught one individual which fed on Natantia (Table 1).

Tab. 1. Food items and their contribution (expressed as % wet weight) for nine elasmobranchs in the N-NW Aegean Sea, Greece, spring 2001- winter 2006. N=number of individuals; TL=total body length; VC=vacuity coefficient

Taxa	Charcharhiniformes		Squaliformes	Rajiformes					Torpediniformes
	Galeus melastomus	*Scyliorhinus canicula*	*Dalatias licha*	*Dasyatis pastinaca*	*Dipturus oxyrinchus*	*Raja clavata*	*Raja miraletus*	*Raja radula*	*Torpedo marmorata*
Cymodocea								0.4	
Polychaeta		3.2		25.4					
Mollusca									
Cephalopoda	93.6	50.2	97.3				31.3		0.3
Crustacea									
Decapoda									
Natantia		0.4		74.6	100.0	36.5	7.8	17.3	
Brachyura		3.5				23.8	60.9	28.1	
Isopoda									0.3
n.i. Crustacea			0.2			1.4		7.9	
Chordata –Vertebrata									
Pisces									
Cepola macrophthalma		0.4							
Engraulis encrasicolus									6.0
Gobiidae									11.1
Gobious sp									12.7
Lesueurigobius suerii		4.3							1.7
Ophichthyidae		2.5							
Sardina pilchardus									26.8
n.i. Pisces	6.4	35.4	2.5			36.3		46.3	41.0
N	3	34	2	1	1	7	3	3	118
TL range (cm)	23.3-54.0	24.1-45.1	38.0-40.2	50.1	81.2	25.6-46.5	22.6-33.9	21.8-32.0	8.8-37.3

Multivariate analysis showed the formation of two distinct groups (cluster analysis: 11.56% similarity; multi-dimensional scaling: stress <0.01, figure not shown) (Fig. 1): one included Charcharhiniformes, Squaliformes and R. miraletus (average similarity=50.55%) and the other one the Torpediniformes and all the remaining Rajiformes (average similarity=34.23%). According to SIMPER, the food items responsible for the dissimilarity of these two groups (average dissimilarity=88.44%) were Cephalopoda and Natantia (average contribution=38.47% and 25.36%, respectively). The main food item for the first group was Cephalopoda (average contribution=94.95%). Cephalopoda were almost absent from the diet of the second group, in which the main prey items were Natantia (average contribution=59.44%) and not identified fish (average contribution=33.19%). Presumably, the consumption of such food items, with different morphological and ecological characteristics, requires swimming ability and morphological features (i.e., dentition, mouth position and large gape) that differ among the species of the two groups. Indeed, the streamlined body shape of the majority of species included in the first group probably allows them to attain higher speeds and accelerations. Conversely, the flattened body form of the species in the second group fit for movement by undulation [6] allowing them to lay on the sandy bottoms and prey upon organisms with low swimming ability. The fact that R. miraletus was included in the first group could be attributed to the large proportions of Cephalopoda in its diet, combined with the small number of individuals examined.

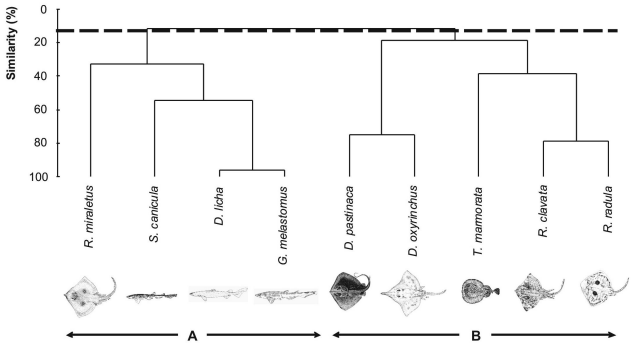


Fig. 1. Cluster analysis for seven flatfishes, based on their feeding habits, from the NW Aegean Sea, Greece, spring 2001- winter 2006. Fish drawings from FishBase (www.fishbase.org; [6])

The trophic level estimates of these species, based on the feeding habits presented here, are given elsewhere [4]. They ranged from 3.46±0.53, for D. pastinaca, to 4.50±0.41, for G. melastomus. Seven of these species had trophic levels >3.7, a fact that classifies them as carnivores [7], thus playing an important role in the trophic structure of marine ecosystems (see also e.g. [8], [9]).

References
1 - Ismen A., 2003. Age, growth, reproduction and food of common stingray (*Dasyatis pastinaca* L., 1758) in Iskenderun Bay, the eastern Mediterranean. *Fish. Res.*, 60 (1): 169-176.
2 - Kabasakal H., 2001. Preliminary data on the feeding ecology of some selachians from the north-eastern Aegean Sea. *Acta Adriat.*, 42 (2): 15-24.
3 - Kyrtatos NA., 1982. Investigation on fishing and biology of the most important fishes of the region around the Aegean Sea. Island of Tinos. *Thalassographica* 5(specl. publ.), 88 pp.
4 - Karachle PK, Stergiou KI., 2008. The effect of season and sex on trophic levels of marine fishes. *J. Fish Biol.*, 72: 1463-1487.
5 - Clarke KR, Gorley RN., 2001. PRIMER v5: User Manual/Tutorial. PRIMER-E: Plymouth.
6 - Froese R, Pauly D (eds)., 2009. FishBase. World Wide Web electronic publication. URL: *www.fishbase.org http//:www.fishbase.org, 5/2009.*
7 - Stergiou KI, Karpouzi VS., 2002. Feeding habits and trophic levels of Mediterranean fish. *Rev. Fish Biol. Fish.*, 11: 217-254.
8 - Ellis JR, Pawson MG, Shackley SE., 1996. The comparative feeding ecology of six species of shark and four species of ray (Elasmobranchii) in the North-East Atlantic. *J. Mar. BIol. Ass. U.K.*, 76 (1): 89-106.
9 - Cortés E., 1999. Standardized diet compositions and trophic levels of sharks. *ICES J. Mar. Sci.*, 56: 707-717.

AGE ESTIMATION OF ALBACORE (*THUNNUS ALALUNGA*) CAUGHT BY PURSE SEINE IN TURKISH WATERS BASED ON DORSAL SPINE READING

F. saadet Karakulak [1]* and Taner Yildiz [1]

[1] Istanbul University, Faculty of Fisheries, Ordu cad. No.200, Laleli, Istanbul, Turkey - karakul@istanbul.edu.tr

Abstract

Lengths of 151 albacore (*Thunnus alalunga*) were measured from 1999 to 2004 in the northern Levantine and Aegean Sea. Fork lengths ranged between 65.0 and 91.5 cm. Age and growth were estimated from seasonally formed bands on the first dorsal spines of 95 specimens. The parameter estimates for the combined sexes were L_∞=100.74 cm, k=0.167 years^{-1} and t_o=-4.878 years. Growth performance index Φ' was 7.435 of all individuals studied. The maximum age was 8 years.

Keywords: Fishes, Pelagic, Growth, Eastern Mediterranean

Introduction

Albacore (*Thunnus alalunga*) is a highly migratory species, found in both subtropical and temperate waters of the three oceans, including the Mediterranean Sea. This species, which has been caught as a by-catch species from bluefin tuna fishery in the Turkish waters, has increasingly been caught by gillnets as the target species in recent years [1]. The catch quantity of albacore has increased remarkably from 73 t in 2006 to 852 t in 2007 [2]. The objective of our study was to estimate albacore age and growth in Turkish waters from growth rings on sections of the first dorsal spine.

Material and Methods

A total of 151 samples were collected during the 1999-2004 from catches by Turkish fishing fleets operating in the northern Levantine and Aegean Seas in bluefin tuna purse seine fisheries. Fishing area depth was 200-2400 m. The first spine of the first dorsal fin was removed from each specimen and fork length (FL), date and area of capture were recorded.

Mean length at age data were used to estimate the growth parameters of the von Bertalanffy growth function $L_t = L_\infty [1-e^{-K(t-to)}]$, where L_t is the total length of fish at time t; K is a growth constant; L_∞ is the asymptotic length; and t_0 the theoretical age at length 0. Growth performance indexes (Φ'=lnk + 2 ln L_∞) were calculated to compare results obtained in this study with results published elsewhere [3].

Results and Discussion

Fork length of all individuals collected ranged from 65.0 to 91.5 cm FL (average value 80.23 ± 0.53 cm). Dominant length class in the total sample was 80-84 cm (Fig.1).

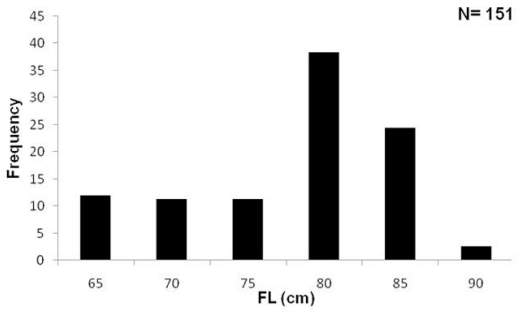


Fig. 1. The fork length distribution of albacore caught in Turkish waters

Age determination and back-calculation analysis was determined from 95 fish of 65.0 to 91.5 cm FL. The age range was between 2 and 8 years. 5- and 6-year-old fish were the most abundant in the samples from the albacore population studied (Tab.1A). The estimated von Bertalanffy growth parameters for sexes combined were L_∞=100.74 cm, k=0.167 years^{-1} and t_o=-4.878 years.

Growth performance index Φ' was 7.435 for all individuals. The comparison of growth parameters and growth performance indexes estimated in the present study and those obtained in previous studies are shown in Tab.1B. The mean growth performance index was significantly lower ($P<0.05$) for the Mediterranean than for Atlantic populations. Compared to Mediterranean sample, north Atlantic populations showed a higher fitted L_∞ (134.4 -140.1 cm).

Tab. 1. A) Observed minimum, maximum and mean length at age for albacore collected in Turkish waters. B) Von Bertalanffy growth parameters and growth performance indexes (Φ') for albacore from different regions

A

Age	Sample size	FL (cm) Min.	Max.	Mean±sd
2	7	68.0	72.0	69.3±1.3
3	10	65.0	81.0	72.1±5.5
4	17	71.0	86.0	79.1±5.9
5	25	74.5	89.0	83.2±3.7
6	24	78.0	89.0	83.4±2.9
7	10	83.5	89.5	86.4±1.7
8	2	87.5	91.5	89.5±2.8

B

Stock- Reference	Methodology	L_∞	K	t_o	Φ'
North Atlantic [4]	scales	134.4	0.183	-0.350	8.103
North Atlantic [5]	dorsal spines	140.1	0.129	-1.570	7.837
Mediterranean [6]	dorsal spines	94.7	0.258	-1.354	7.746
This study	dorsal spines	100.7	0.167	-4.878	7.435

The absence of 0- and 1-years-old individuals in the purse seine fisheries of the Turkish waters may be associated with the habitat and behaviour of these young fish. 5- and 6-year-old fish were the most abundant in the purse seine fisheries. However, 2 and 3 years old individuals are more dominant for the long-line fisheries in the Aegean Sea [6]. This situation may be attributed to the selectivity of the fishing gear.

Acknowledgements : This study was financially supported by TUBITAK project 108O483 and the Research Fund of The University of Istanbul with the project number BYP/1761.

References

1 - Karakulak, F.S.,Bilgin, B. and Gökoglu, M., 2007.Albacore (*Thunnus alalunga* Bonnaterre 1788) fishery in the Antalya Bay (Levantine Basin). *Rapp. Comm. Int. Mer Medit.* 38: 512.

2 - TUIK, 2007., Fisheries Statistics 2007. Turkish Statistical Institute, 48 p., Ankara.

3 - Sparre, P. and Venema, S.C., 1992. Introduction to tropical fish stock assessment. Part 1 Manual. FAO Fisheries Technical Paper No.306/1, Rev.1., 376 p., Rome.

4 - Bard, F.X., 1974. Etude sur le germon (*Thunnus alalunga* Bonnaterre 1788) de l'Atlantique Nord. Elements de dynamique de population. Col.Vol.Sci.Pap.ICCAT,2:198-224.

5 - Gonzalez-Garces, A. and Farina-Perez, A.C., 1983. Determining age of young albacore, *Thunnus alalunga*, using dorsal spines. US. Dept. Comm., *NOAA Tech. Rep.*NMFS 8: 117-271.

6 - Megalofonou, P., 2000. Age and growth of Mediterranean albacore, *J. Fish. Biol.*, 57(3): 700-715.

ON A COLLECTION OF OPISTHOBRANCHS (MOLLUSCA, GASTROPODA) FROM THE LEVANTINE COAST OF TURKEY

S. Ü. Karhan [1]*, E. Kalkan [2], M. B. Yokes [3], H. Balkis [1] and C. Dalyan [1]
[1] Department of Biology, Istanbul University - unsalkarhan@yahoo.com
[2] Institute of Environmental Sciences, Bogaziçi University
[3] Department of Molecular Biology and Genetics, Haliç University

Abstract
A small collection containing ten species of opisthobranch gastropods reported here from the Levantine coast of Turkey. Of these species *Facelina annulicornis* and *Pruvotfolia pselliotes* are new records for the Levantine Sea.
Keywords: Gastropods, Mollusca, Levantine Basin

The knowledge of opisthobranch fauna of the Levantine Sea is very incomplete and needs to be improved when compared to the other parts of the Mediterranean. Although, some contemporary studies from Turkish coast [e.g. 1,2] have provided important insights into the Opisthobranch fauna of the region, most of the current knowledge is based upon some old studies from Turkish and Israeli coasts [e.g. 3,4].

The specimens reported here were obtained during a faunistic survey conducted on the coasts of Samandag and Yayladagi (Levantine coast of Turkey, close to the Turkish-Syrian border) between October 2008 and May 2009. Collection of the specimens was carried out by SCUBA diving. All specimens were photographed alive, were preserved in 70% ethanol and are stored in the Istanbul University Science Faculty Hydrobiology Museum, Turkey. Of the ten opisthobranch species identified *Facelina annulicornis* and *Pruvotfolia pselliotes* are new records for the Levantine Sea.

Collection

Aplysia parvula Guilding in Morch, 1863
Material examined: Yayladagi, 35°57'05"N, 35°55'10"E, under stone, depth 9 m, 02.V.2009, 1 specimen
Previous records from Levantine Sea: Turkey, Gulf of Fethiye [1], Gulf of Antalya [2]; Israel [4]

Aplysia depilans Gmelin, 1791
Material examined: Yayladagi, 35°57'05"N, 35°55'10"E, under stone, depth 4 m, 02.V.2009, 1 specimen; 35°58'59"N, 35°57'22"E, under stone, depth 6 m, 03.V.2009, 1 specimen
Previous records from Levantine Sea: Turkey, Mersin [3], Tasucu [5], Kas and Gulf of Antalya [2]

Pleurobranchus testudinarius Cantraine, 1835
Material examined: Yayladagi, 35°58'59"N, 35°57'22"E, on sand, under stone, depth 6 m, 03.V.2009, 1 specimen
Previous records from Levantine Sea: Turkey, Kas [2], Gulf of Antalya [1,2]; Israel [4]

Hypselodoris picta (Schultz, 1836)
Material examined: Yayladagi, 35°57'05"N, 35°55'10"E, rocky, depth 7 m, 02.V.2009, 1 specimen
Previous records from Levantine Sea: Turkey, Kas [1], Gulf of Antalya [1,2]; Israel [4]

Hypselodoris infucata (Ruppell & Leuckart, 1830)
Material examined: Yayladagi, 35°57'05"N, 35°55'10"E, under stone, depth 3-5 m, 02.V.2009, 3 specimens
Previous records from Levantine Sea: Turkey, Gulf of Iskenderun [6], Gulf of Fethiye [7]; Israel [8]

Flabellina rubrolineata (O'Donoghue, 1929)
Material examined: Samandag, 36°10'23"N, 35°52'43"E, rocky, depth 12 m, 25.X.2008, 1 specimen
Previous records from Levantine Sea: Turkey, Kas [2,7], Gulf of Antalya [2,7,9]; Israel [10]

Dondice banyulensis Portmann & Sandmeier, 1960
Material examined: Yayladagi, 35°58'59"N, 35°57'22"E, rocky, depth 16 m, 03.V.2009, 1 specimen
Previous records from Levantine Sea: Turkey, Mediterranean coast [9], Kas and Gulf of Antalya [1,2]

Spurilla neapolitana (Delle Chiaje, 1823)
Material examined: Yayladagi, 36°00'34''N, 35°58'48''E, rocky, depth 3 m, 03.V.2009, 1 specimen
Previous records from Levantine Sea: Turkey, Kas [2], Gulf of Antalya [3]

Facelina annulicornis (Chamisso & Eysenhardt, 1821)
Material examined: Yayladagi, 36°00'34''N, 35°58'48''E, rocky, depth 3 m, 03.V.2009, 1 specimen
Remarks: This species recorded for the first time from the Levantine Sea. The closest records are from Bodrum (Turkish Aegean coast) and Istanbul (Sea of Marmara) [2].

Pruvotfolia pselliotes (Labbe, 1923)
Material examined: Yayladagi, 35°58'59"N, 35°57'22"E, under stone, depth 6 m, 03.V.2009, 1 specimen
Remarks: This species recorded for the first time from the Levantine Sea. The closest record is from Istanbul (Sea of Marmara) [2].

References

1 - Türkmen A. and Demirsoy A., 2009. Contributions to the Eastern Mediterranean Opisthobranchia (Mollusca:Gastropoda) Fauna of Turkey. *Turkish Journal of Zoology*, 33:57-68.
2 - Yokes M.B., 2009 Additions to the knowlegde of opisthobranchia from Turkey. Triton, 20:5-19.
3 - Swennen C., 1961. On a collection of Opisthobranchia from Turkey. Zoologische Mededelingen, 38: 41-75.
4 - Barash A. and Danin Z., 1971. Opisthobranchia (Mollusca) from the Mediterranean waters of Israel. Israel Journal of Zoology, 20: 151-200.
5 - Buzzurro G. and Greppi E., 1996. The lessepsian molluscs of Tasuçu (South-East Turkey). *La Conchiglia*, 28 suppl. (279): 3-22.
6 - Çevik C. and Öztürk B., 2001. A new lessepsian mollusc *Hypselodoris infucata* (Rüppell and Leuckart, 1830) (Gastropoda: Nudibranchia) for the coasts of Turkey. *Turkish Journal of Zoology*, 25: 27-30.
7 - Yokes M.B. and Rudman W.B., 2004a. Lessepsian Opisthobranch from Southwestern Coast of Turkey; Five New records for Mediterranean. Rapports et procès-verbaux des réunions Commission Internationale pour l'exploration scientifique de la Mer Méditerranée, 37: 557.
8 - Barash A. and Danin Z., 1973. The Indo-Pacific species of mollusca in the Mediterranean and notes on a collection from the Suez canal. *Israel Journal of Zoology*, 21(3-4): 301-374.
9 - Yokes M.B. and Rudman W.B., 2004b. Aeolidiina (Opisthobranchia, Gastropoda) species recorded in Turkish waters: 11 new records for Turkey. In: Gencel C, Özgüle M.C., Kemik N. and Egi S.M. (Eds.) SBT 2004, 8th Underwater Science and Technologies Meeting Proceedings, 26-28 November 2004, Istanbul, Turkey, pp:60-69 (in Turkish).
10 - Gat G., 1993. *Flabellina rubrolineata* (O'Donoghue) and *Phidiana indica* (Bergh) (Nudibranchia Aeolidioidea), two new Lessepsian immigrants in the Eastern Mediterranean. *Journal of Molluscan Studies*, 59: 120.

POPULATION DYNAMICS OF DEEP-WATER PINK SHRIMP *PARAPENAEUS LONGIROSTRIS* (LUCAS, 1846) AT MONTENEGRIN SHELF (SOUTH ADRIATIC)

Olivera Kasalica [1]* and Slobodan Regner [2]
[1] Institute of Marine Biology, P.O.Box 69, 85 330 Kotor, Montenegro - okasalica@yahoo.com
[2] Institute for Marine Biology, Kneza Viseslava 1, 11 030 Belgrade, Serbia

Abstract
The deep-weater pink shrimp *Parapenaeus longirostris* (Lucas, 1846) presents an economically significant species in Montenegrin trawling fishery. The objectives of this work were to investigate population dynamics. Population of this species on the shelf of Montenegrin coast is not threatened by high rate of trawler fishing.
Keywords: Adriatic Sea, Continental Shelf, Decapoda, Population Dynamics

Introduction
Parapenaeus longirostris (Lucas, 1846) is a decapod species that is widely distributed on the Montenegrin shelf, and since late 1990-ties it is an object of especially big commercial importance. As for the Montenegrin coast there were no data that could be used to follow up the population dynamics of this species', the task was to study the population structure in this area for the first time, to determine the main population parameters (length-weight relationships, growth parameters, mortality rates), estimate of biomass (relative and absolute) as well as maximal biological sustainable yield (MSY).

Materials and Methods
The material was collected by commercial trawlers in period March 2003 - June 2004, at depths of 20 - 120 m, including one quarter of the total area of shelf. Data include catch from 13 trawling hauls, duration of which was from 1.17 to 4 hours. The weight of the total catch and the weight of deep-water pink shrimp catch was measured on the ships, while statistical analysis was performed in Institute of Marine biology in Kotor. The parameters of the length - weight relationship were determined. The growth parameters were obtained using the Von Bertalanffy growth equation and the Bhattacharya method [1] using FISAT computer program [2]. Two methods were used for the estimation of total mortality (Z): length converted catch curve method [3] and method which is based on the relationship between Z and the mean total length [4]. Natural mortality M was estimated using Pauly's formula [3]. Fishing mortality F was calculated as: F = Z - M and exploitation rate E as: E = F / Z. Yield per recruit was estimated using the Beverton-Holt model [5]. For estimating MSY we used Cadima's formula (MSY = 0.5 * Z * B) [6]. Beddington and Cooke [7] concluded that formula generally overestimates MSY 2 to 3 times, so we used 0.2 instead 0.5. to get better estimate of MSY.

Results and Discussion
Values of powers of length-weight relationships is b = 2.37 for the total sample, b = 2.41 for males and b = 2.33 for females; while values for total length (TL) are b = 2.9 for total sample, b = 2.84 for males and b = 2.89 for females. The estimated growth parameters are L_∞ = 47 mm and K = 0.7 for carapace length (CL), while for total length (TL) L_∞ = 146 mm and K = 0.9. The calculated mean value of rate of total immediate mortality (Z) is 3.48, while mean value of rate of natural mortality (M) is 1.5. Value of the fishing mortality is 1.98. The estimated mean value of relative biomass (B_r) is 69.3 kg/km^2, while the total relative biomass of whole studied area is 67.6 tons. The calculated total relative biomass and coefficient of vulnerability q = 0.6455 were used to estimate the absolute biomass, which yields (B_a) 112.63 tons, while MSY of the studied area is 78.39 tons per year. As the value of maximal allowed exploitation rate is E_{max} = 0.564, and the real exploitation rate is E = 0.3, we may conclude that the population of *Parapenaeus longirostris* on the Montenegrin shelf is not yet threatened by the present fishing effort of the trawl fishery.

References
1 - Bhattacharya, C. G., 1967. A simple method of resolution of a distribution into Gaussian components. *Biometrics*, 23: 115-135.
2 - Gayanilo, F.C., Sparre P. and Pauly D., 1995. The FAO-ICLARM Stock Assessment Tools (FiSAT) User's Guide. *FAO Computerized Information Series (Fisheries)*. 8:126p
3 - Pauly, D., 1983. Lenght-converted catch curves. A powerful tool for fisheries research in the tropics. *ICLARM Fishbyte*, 1 (2): 9-13.
4 - Beverton, R.J.H. and S.J. Holt., 1956. A review of methods for estimating mortality rates in exploited fish populations, with special reference to sources of bias in catch sampling. *Rapp. P.-v. Réun. Cons. Perm. int. Explor. Mer*, 140 (1): 67-83.
5 - Beverton, R.J.H. and S.J. Holt., 1966. Manual of methods for fish stock assessment. Part 2. Tables of yield functions. *FAO Fish. Tech. Rap.*, 38 (Rev.1): 67p.
6 - Troadec, J.P., 1977. Méthodes semi-quantitatives d' évaluation. *FAO Circ. Pêches*, 701: 131-141.
7 - Beddington, J.R. and. Cooke J.G., 1983. The potential yield of fish stocks. *FAO Fish. Tech. Pap*., (242): 47 p.

IMPACT OF MARINE LITTER ON SEA LIFE: A REVIEW

Stelios Katsanevakis [1]* and Yiannis Issaris [1]
[1] Hellenic Centre for Marine Research - skatsan@ath.hcmr.gr

Abstract

Marine litter (i.e., any manufactured or processed solid material that enters the marine environment) is a greatly underestimated component of marine pollution. Herein the impact of marine litter on sea life is reviewed. The entanglement of marine species, especially marine mammals, seabirds, turtles, fish, and crustaceans has been frequently described as a serious mortality factor. Marine species may ingest litter items, which has many harmful effects on their physical condition and survival. Other impacts include toxic contaminants entering food webs, assistance of the invasion of alien species, altering the structure of benthic biocommunities, and damage to coral reefs and coral facies.

Keywords: Plastics, Pollution, Mortality

Marine litter (or marine debris) is any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment from any source [1]. Although there are various types of litter, plastics (synthetic organic polymers) make up most of the marine debris worldwide. Most marine litter originates from land-based activities, and the main sources include storm water discharges, municipal landfills located near the coast, riverine transport of waste from landfills and other sources, discharges of untreated municipal sewage, unregulated disposal of litter due to absence of waste services or landfills, tourism, all types of vessels, offshore oil and gas platforms, and aquaculture installations. Litter densities that reach many thousands or even millions of items per hectare have been reported on the seafloor or along beaches [2]. Mediterranean is among the areas with the highest reported marine litter densities [2].

A direct threat to marine life is entanglement in loops or openings of floating or sunk marine litter. The most problematic marine litter for entanglement appears to be lost or discarded fishing gear, six-pack plastic rings, and packing strapping bands. Entangled animals may get killed by drowning, suffocation, or strangulation. Even if they manage to survive, entangled animals may suffer restricted efficiency of movement and swimming, and thus an impaired ability to catch food and avoid predators, whilst their demand for food may increase significantly due to elevated energetic costs [3]. Entanglement could cause lacerations and infections from the abrasive or cutting action of attached litter. In addition, entangled animals may exhibit altered behavior patterns that place them at a survival disadvantage [4].

The entanglement of marine species in marine litter, especially marine mammals, seabirds, turtles, fish, and crustaceans, has been frequently described as a serious mortality factor. Derelict or discarded fishing gear may continue to fish for years, a process that has been termed 'ghost' fishing. Many marine species interact with marine litter as a result of their normal behavior patterns and suffer by high rates of entanglement. Entanglement in marine litter has been reported for at least 20 pinniped species, i.e. 61% of existing species worldwide, at least 14 cetaceans: six species of baleen whales and eight species of toothed whales, and all seven species of marine turtles (Table 1).

The impact of entanglement in marine litter on marine populations is difficult to quantify as unknown number of marine animals die at sea and decompose without being recorded. Animals that become entangled and die may quickly sink or be consumed by predators at sea, eliminating them from potential detection. Some endangered species may be very rare and their detection quite difficult, so that entanglement incidents to marine litter are scarce and almost impossible to detect even with intense sampling efforts. Hence, the estimated mortality rates and the effects on the population dynamics of many affected species are probably underestimated [2].

Many marine species such as marine mammals, seabirds, marine turtles, and fish have been reported to ingest marine litter, especially plastics. Ingestion of marine litter may occur either because of misidentification of litter as natural prey or accidentally during feeding and normal behavior. The most serious effects of ingested litter are the blockage of the digestive tract and internal injuries by sharp objects, which may be a cause of mortality. Other harmful effects include blockage of gastric enzyme ingestion, diminished feeding stimulus, nutrient dilution, reduced growth rates, lowered steroid hormone levels, delayed ovulation and reproductive failure, and absorption of toxins [5]. At least 32 species of cetaceans (43% of existing species worldwide) and all species of marine turtles have been reported to ingest marine litter (Table 1).

All Mediterranean marine mammals and marine turtles have been reported to either ingest or get entangled in marine debris, i.e. the Mediterranean monk seal (entanglement), all three marine turtles, and all 14 cetaceans that either have permanent populations or are occasionaly observed in the Mediterranean (entanglement: 8/14; ingestion: 13/14).

Plastics may release toxic chemicals when ingested because of the chemical additives they contain. Several additives like nonylphenols, polybrominated diphenyl ethers, phtalates, and bisphenol A are used as plasticizers or are added to plastic during production to give it desirable properties. Furthermore, plastics have the potential to absorb hydrophobic pollutants like PCBs and DDT from seawater. There is great concern about the possible transfer of these toxic pollutants to marine organisms due to plastic ingestion [5], [6].

Other known impacts of marine litter include altering the structure of benthic communities [7], causing damage to coral reefs and coral facies [8], and assisting invasions of alien species [9].

Tab. 1. Species of marine mammals and turtles with records of entanglement (EN) or ingestion (IN) of marine litter. Species with permanent populations or occasionally observed in the Mediterranean are marked with an asterisk

Taxon	Affected species by marine debris
Pinnipeds	*Arctocephalus australis* (EN), *Arctocephalus forsteri* (EN), *Arctocephalus gazella* (EN), *Arctocephalus philippii* (EN), *Arctocephalus pusillus* (EN), *Arctocephalus townsendi* (EN), *Callorhinus ursinus* (EN), *Eumetopias jubatus* (EN, IN), *Halichoerus grypus* (EN), *Hydrurga leptonyx* (EN), *Mirounga angustirostris* (EN, IN), *Mirounga leonina* (EN), *Monachus monachus** (EN), *Monachus schauinslandi* (EN), *Neophoca cinerea* (EN), *Otaria flavescens* (EN), *Phoca groenlandica* (EN), *Phoca vitulina* (EN), *Phocarctos hookeri* (EN), *Zalophus californianus* (EN)
Cetaceans	*Balaena mysticetus* (EN, IN), *Balaenoptera acutorostrata** (EN, IN), *Balaenoptera edeni* (IN), *Balaenoptera physalus** (IN), *Berardius berdii* (IN), *Delphinus delphis** (IN), *Eschrichtius robustus* (EN), *Eubalaena australis* (EN), *Eubalaena glacialis* (EN), *Globicephala macrorhynchus* (IN), *Globicephala melas** (IN), *Grampus griseus** (EN, IN), *Hyperoodon ampullatus* (IN), *Kogia breviceps* (IN), *Kogia simus* (IN), *Lagenorhynchus albirostris* (IN), *Lagenorhynchus obliquidens* (IN), *Lissodelphis borealis* (IN), *Megaptera novaengliae** (EN), *Mesoplodon densirostris* (IN), *Mesoplodon europeus* (IN), *Mesoplodon stejnegeri* (IN), *Neophocoena phocoenoides* (IN), *Orcinus orca** (EN, IN), *Phocoena phocoena** (EN, IN), *Phocoenoides dalli* (EN, IN), *Physeter macrocephalus** (EN, IN), *Pontoporia blainvillei* (IN), *Pseudorca crassidens** (IN), *Sotalia fluviatilis* (IN), *Sotalia guianensis* (IN), *Stenella attenuata* (IN), *Stenella coeruleoalba** (EN, IN), *Steno bredanensis** (IN), *Tursiops aduncus* (EN), *Tursiops truncatus** (EN, IN), *Ziphius cavirostris** (IN)
Turtles	*Caretta caretta** (EN, IN), *Chelonia mydas** (EN, IN), *Dermochelys coriacea** (EN, IN), *Eretmochelys imbricata* (EN, IN), *Lepidochelys kempi* (EN, IN), *Lepidochelys olivacea* (EN, IN), *Natator depressus* (EN, IN)

References

1 - Coe J.M. and Rogers D.B., 1997. Marine debris: sources, impacts, and solutions. New York, NY: Springer.

2 - Katsanevakis S., 2008. Marine debris, a growing problem: Sources, distribution, composition, and impacts. In: Hofer T.N. (ed.), Marine Pollution: New Research. Nova Science Publishers, New York, pp 53-100.

3 - Feldkamp S., Costa D., DeKrey G.K., 1989. Energetics and behavioral effects of net entanglement on juvenile northern fur seals *Callorhinus ursinus*. *Fish. Bull*., 87: 84-94.

4 - Laist D.W., 1987. Overview of the biological effects of lost and discarded plastic debris in the marine environment. *Mar. Poll. Bull*. 18: 319-326.

5 - Derraik J.G.B., 2002. The pollution of the marine environment by plastic debris: a review. *Mar. Poll. Bull*. 44: 842-852.

6 - Ryan P.G., Connell A.D. and Gardner B.D., 1988. Plastic ingestion and PCBs in seabirds: is there a relationship? *Mar. Poll. Bull.* 19: 174-176.

7 - Katsanevakis S., Verriopoulos G., Nikolaidou A. and Thessalou-Legaki M., 2007. Effect of marine pollution with litter on the benthic megafauna of coastal soft bottoms. *Mar. Poll. Bull*. 54: 771-778.

8 - Donohue M.J., Boland R.C., Sramek C.M. and Antonelis G., 2001. Derelict fishing gear in the Northwestern Hawaiian Islands: diving surveys and debris removal in 1999 confirm threat to coral reef ecosystems. *Mar. Poll. Bull*. 42: 1301-1312.

9 - Barnes D.K.A., 2002. Invasions by marine life on plastic debris. *Nature* 416: 808-809.

DNA DAMAGE AND REPAIR EFFICIENCY COMET ASSAY IN INTENSIVELY REARED SEA BREAM (*SPARUS AURATA*), EXPOSED TO HEAVY METALS

M. Kavouras [1]*, E. E Malandrakis [1], S. Dailianis [2], O. Dadali [1], K. Chatzipli [1], E. Golomazou [1], P. Panagiotaki [1], M. Kaloyianni [3] and A. Exadactylos [1]

[1] Department of Ichthyology & Aquatic Environment, School of Agricultural Sciences, University of Thessaly - melios72@yahoo.gr

[2] Department of Animal Biology, School of Biology, University of Patras

[3] Department Of Zoology, School Of Biology, Aristotle University Of Thessaloniki

Abstract

The aim of this study was the detection of DNA damage and repair efficiency, in hepatocytes of sea bream (*Sparusaurata*), under copper (Cu^{++}) and zinc (Zn^{++}) experimental exposure. The results illustrated a different cellular behaviour between metals' exposure, implying variant response mechanisms to stress. Moreover, the contribution of repair processes in DNA fragmentation of hepatocytes is discussed.

Keywords: Aquaculture, Ecotoxicology, Metals, Pollution, Trace Elements

Introduction

Zinc and copper are natural elements occurring in aquatic ecosystems. On trace amounts within a narrow optimal concentration range, they are essential to living organisms. However, metal concentrations can become toxic to hydrobionts due to anthropogenic load on hydrosphere. Both zinc and copper are common metal cofactors conducting an important role in a plethora of fundamental biological processes [1] especially in the metabolic pathway. The scope of the present work was to study sublethal metal genotoxicity in gilthead sea bream (*Sparus aurata)* hepatocytes. The selected concentrations were directly comparable to marine pollution levels.

Materials and Methods

Three hundred and twenty specimens of gilthead sea bream, *Sparus aurata*, (70±10g) were provided from a local breeding farm in northern Evoikos Gulf. They were acclimatized for one month at the University facilities in 500L tanks. Different replicates of fish were exposed to 0.1 and 0.5ppm of $CuSO_45H_2O$ and 0.2 and 1.0ppm of $ZnCl_2$ for 24 and 96 hours. Livers were dissected from three specimens per treatment. Hepatocytes' isolation protocol was conducted according to [2]. Cell counting was carried out using a Neubauer haemocytometer and their viability was determined with eosin staining. Cell suspensions were divided into two aliquots, referring for the direct damage assessment (first assay) and the estimation of repair efficiency (second assay). DNA fragmentation was assessed using a slightly modified protocol of the alkaline comet assay [3]. In order to estimate the involvement of repair mechanisms in DNA fragmentation, 1ml of isolated hepatocytes was placed in a 5ml culture medium and was incubated for 2h in room temperature (metal-free treatment). Two microscope slides per specimen and 100 cells per slide were analyzed for both assays. Comet-shape structure was examined using a fluorescent microscope and was scored with the open-source image analysis package CASP [4].DNA damage was evaluated by computing the tail moment (TM) parameter [5]. Kruskal-Wallis tests were adopted for the statistical analysis [6].

Results and Discussion

TM parameters are presented in Fig. 1. Significant DNA fragmentation was detected on specimens exposed to both zinc and copper, compared with the control ones. Incubated hepatocytes in the metal free medium showed higher DNA fragmentation compared to those directly assayed. This significant difference in the TM values denotes an increased repair activity leading to substitution of the damaged DNA segments [7]. DNA fragmentation of specimens exposed to copper for either 24 or 96h revealed a significant increase in the higher concentration in both assays. Regarding the incubation in the metal-free medium, specimens' exposure to low copper concentration was non-significant in comparison with the control ones. The fact that a time response to copper exposure was detected only in the second assay could be explained by a delayed activation of the detoxification mechanisms [8]. On the other hand, specimens exposed to the high zinc concentration presented maximum DNA fragmentation in either 24 or 96h, indicating elevated genotoxicity. Furthermore, a significant time response to zinc exposure, similar to copper exposure, was observed in the metal-free medium incubation. Only this time there was a significant decrease rather than the observed increased pattern in the TM values regarding copper exposure. A possible explanation is that exposure to high zinc concentrations directly affects DNA repair mechanisms. The different assayed cellular behaviour pattern between specimens exposed to copper and zinc could be explained by variant response mechanisms to each metal [8]. Fish exposure to copper seems to instantly activate detoxification mechanisms. Adversely, zinc seems to inhibit their DNA repair activity.

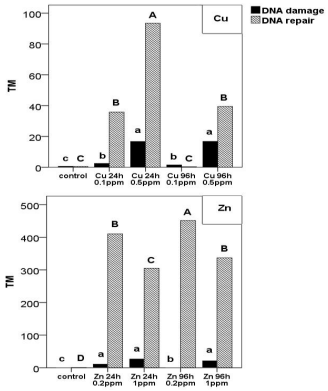


Fig. 1. Median TM values for all treatments. Significancies among bars are noted with different letters (*P<0.05*)

References

1 - Carpene E., Andreani G., Monari M., Kindt M. and Isani G., 2003. Biochemical changes during post-larval growth in white muscle of gilthead sea bream (*Sparus aurata*) fed zinc-fortified diets. *Vet. Res. Commun.* 27: 215-218.

2 - Singh N.P., McCoy M.T., Tice R.R. and Schneider E.L., 1988. A Simple Technique for Quantitation of Low-Levels of DNA Damage in Individual Cells. *Exp. Cell Res.* 175: 184-191.

3 - Mitchelmore C.L. and Chipman J.K., 1998. Detection of DNA strand breaks in brown trout (*Salmo trutta*) hepatocytes and blood cells using the single cell gel electrophoresis (comet) assay. *Aquat. Toxicol.* 41: 161-182.

4 - Konca K., Lankoff A., Banasik A., Lisowska H., Kuszewski T., Gozdz S., Koza Z. and Wojcik A., 2003. A cross-platform public domain PC image-analysis program for the comet assay. *Mutat. Res-Gen. Tox. En.* 534: 15-20.

5 - Villarini M., Scassellati-Sforzolini G., Moretti M. and Pasquini R., 2000. In vitro genotoxicity of terbutryn evaluated by the alkaline single-cell microgel-electrophoresis "comet" assay. *Cell Biol. and Toxicol.* 16: 285-292.

6 - Zar J.H., 1996. Biostatistical analysis, 3rd ed. Upper Saddle River, N.J, Prentice Hall.

7 - Speit G. and Hartmann A., 1995. The contribution of excision repair to the DNA-effects seen in the alkaline single cell gel test (comet assay). *Mutagenesis* 10: 555-559.

8 - Gabbianelli R., Lupidi G., Villarini M. and Falcioni G., 2003. DNA Damage Induced by Copper on Erythrocytes of Gilthead Sea Bream *Sparus aurata* and Mollusk *Scapharca inaequivalvi*. *Arch. Environ. Con. Tox.* 45: 350-356.

THE STATUS OF THE DEMERSAL FISH COMMUNITY IN THE GULF OF ANTALYA, TURKEY (LEVANTINE SEA)

T. Kebapçioglu [1]*, E. Özgür özbek [1], M. Çardak [2], M. Gökoglu [1] and C. R. Begburs [1]
[1] Akdeniz University, Faculty of Fisheries - turhank@akdeniz.edu.tr
[2] Istanbul University, Faculty of Fisheries

Abstract
This paper presents the results of the bottom trawl survey carried out in the Gulf of Antalya in the summer period of 2009 in order to determine the catch composition, abundance and biomass of the demersal fish stocks. A total of 84 fish species were identified. *Gymnura altavela* (Linnaeus, 1758), *Mullus barbatus* Linnaeus, 1758, *Dasyatis pastinaca* (Linnaeus, 1758), *Pagellus erythrinus* (Linnaeus, 1758) and *Epinephelus aeneus* (Geoffroy Saint-Hilarie, 1817) are the species that have the highest biomass index values.
Keywords: Trawl Surveys, Demersal, Fishes, Biomass, Eastern Mediterranean

Introduction
The Gulf of Antalya locates in the Norteastern Levantine Basin and is characterized by high temperature, salinity and oligotrophy. Few studies concerning the demersal fish community of the shallow continental shelf area of the Northeastern Levant Sea are available [1,2,3]. This paper presents the first detailed information on the demersal fish community of the Gulf of Antalya.

Material and Methods
This research was carried out in August 2009, in the Gulf of Antalya, between the depths of 25-200 m, using a commercial bottom trawl net. The cod-end mesh size was 22 mm (knot to knot). The samples were collected day time with 2.5 n.m./h average trawling speed. The geographical coordinates of 30 trawling stations vary between N36° 52' 48.5 - 36° 23' 00.0'' - E31° 32 32.2' - E30° 31' 11.3''. The total catch from each haul was identified to species, counted, weighed and standardized to unit trawling hour. The stock amount is calculated according to the swept area method; the catch weight (Cw) divided by the swept area (a) for each species and for each haul [4]. The swept area (a) for each hauling was estimated thus: $a = D.h.X$ (h: length of the head-rope, *D:* cover of distance, X: fraction of the headrope length which is equal to the width of the path swept by the trawl (accepted as 0.5).

Results
A total of 30 hauls were carried out at the depths of 25, 50, 75, 100, 150, 200 m. The average catch was 83.38±15.54 kg/hour (±se), average biomass 4188.77±797.93 kg/nm^2 (±se) or 1221.25±232.64 kg/km^2 (±se) and average abundance 63049±8181 ind./nm^2 (±se) or 18382±2385 ind./km^2 (±se) (Tab.1).

Tab. 1. The number of hauls, average catch (kg/hour (±se)), biomass (kg/nm^2 (±se)), abundance (ind./nm^2 (±se)), and number of species at six depth levels in the Gulf of Antalya.

Depth (m)	Number of hauls	Average catch kg/hour (±se)	Average biomass kg/nm^2(±se)	Average abundance ind./nm^2(±se)	Number of Species
25	6	122.8 ±54.11	6294.99 ±2906.27	88997 ±22156	56
50	6	92.37 ±28.49	4641.18 ±1452.14	54819 ±13728	61
75	6	55.82 ±7.99	2814.59 ± 389.04	54117 ±11807	54
100	6	98.89 ±44.93	4838.31 ±2179.65	60775 ±25678	38
150	4	60.92 ±27.82	3047.09 ±1365.52	70345 ±22946	40
200	2	19.21 ±6.21	970.15 ± 310.00	28924 ±5703	22
Total	30	83.38±15.54	4188.77 ± 797.93	63049 ±8181	84

Among the total of 84 fish species identified, 75 were osteichthyes, and 9 chondrichthyes. The 26 species, that have higher biomass index than 15 kg/nm^2 are given in Table 2. *Gymnura altavela* (Linnaeus, 1758), *Mullus barbatus* Linnaeus, 1758, *Dasyatis pastinaca* (Linnaeus, 1758), *Pagellus erythrinus* (Linnaeus, 1758) and *Epinephelus aeneus* (Geoffroy Saint-Hilarie, 1817) are the species that have the highest biomass index values and *M. barbatus* Linnaeus, 1758, *P. erythrinus* (Linnaeus, 1758), *Bothus podas* (Delaroche, 1809), *Citharus linguatula* (Linnaeus, 1758), and *Lepidotrigla cavillone* (Lacepède, 1801) have the highest abundance.

Tab. 2. The frequency of occurrence (%), biomass index (kg/nm^2 (±se)), and abundance (ind./nm^2 (±se)) of the species caught in the Gulf of Antalya.

	Biomass index		Abundance		Freq. of occur. (%)
	kg/nm^2	se	Ind./nm^2	se	
CHONDRICHTHYES					
Dasyatis pastinaca	524.5	173.60	271,3	78.76	60.00
Gymnura altavela	1106.3	558.65	145.5	48.22	50.00
Mustelus mustelus	49.0	27.64	31.4	11.56	26.67
Raja clavata	41.6	11.85	89.9	22.35	56.67
Rhinobatos rhinobatos	49.0	24.35	31.1	15.46	20.00
OSTEICHTHYES					
Boops boops	23.0	11.66	483.3	173.74	50.00
Bothus podas	52.5	23.46	5892.1	2627.46	70.00
Chelidonichthys lucerna	24.7	8.77	461.9	171.48	66.67
Citharus linguatula	104.9	27.65	5562.0	1714.84	86.67
Dentex dentex	16.5	5.92	248.5	105.17	30.00
Diplodus annularis	65.2	30.92	1895.9	860.29	50.00
Epinephelus aeneus	204.5	64.88	191.4	78.15	60.00
Lagocephalus sceleratus	17.8	6.12	69.1	21.19	36.67
Lagocephalus suezensis	31.7	19.31	724.1	392.17	36.67
Lepidotrigla cavillone	52.4	17.60	4355.4	1438.61	63.33
Lithognathus mormyrus	17.2	9.85	232.1	147.10	20.00
Merluccius merluccius	15.5	11.15	103.7	59.06	16.67
Mullus barbatus	856.7	199.80	22484.3	4361.92	100.00
Pagellus acarne	17.0	8.55	734.0	259.13	46.67
Pagellus erythrinus	415.4	107.11	6197.5	1556.22	93.33
Saurida undosquamis	112.6	31.40	726.0	208.29	83.33
Serranus cabrilla	24.1	7.19	604.7	159.76	83.33
Spicara sp.	91.5	42.42	4214.5	1705.47	70.00
Trigloporus lastoviza	53.0	22.22	1495.7	679.26	50.00
Upeneus moluccensis	47.7	18.21	797.1	223.15	83.33
Uranoscopus scaber	24.5	11.59	187.3	86.11	53.33

Discussion
This research was conducted in the "pre-fishing" season both in the fishing-prohibited and open areas and will continue for four seasons. The aim of the research is to determine the seasonal and spatial distribution of the demersal species in the Gulf of Antalya. This paper presents the preliminary data of the research but this is the first detailed information on the demersal fish community of the Gulf of Antalya. In the Gulf of Antalya, the catch composition of bottom trammel nets at max.10 m depth was studied by [3] and 73 fish species were reported. The 84 fish species found in this study is far below the number of fish species (165), given by [1] for the Gulfs of Iskenderun and Mersin. Thus long-term approaches are required for the completion of the species list; determine the distribution and status of the stocks, if the lack of relevant literature from this region is concerned.

References
1 - Gücü A.C. and Bingel F., 1994. Trawlable species assemblages on the continental shelf on the North Eastern Levant Seas (Mediterranean) with an emphasis on Lessepsian migration. *Acta Adriat.*, 35: 83-100.
2 - Begburs C.R. and Kebapçioglu T., 2007. An investigation on catch composition of bottom trammel nets used in Antalya Bogazkent. *E.U. J. Fish. Aquat. Sci*., 24 (3-4): 283–286.
3 - Mutlu E. and Ergev M.B., 2008. Spatio-temporal distribution of soft-bottom epibenthic fauna on the Cilician shelf (Turkey), Mediterranean Sea. *Rev. Biol. Trop.* 56 (4): 1919-1946.
4 - Spare P. and Veneme S.C. 1992. Introduction to Tropical Fish Stock Assesment (Part 1). *FAO Fish. Tech. Pap.*, Rome.

DISTRIBUTION OF DEMERSAL FISH SPECIES IN THE BLACK SEA, SEA OF MARMARA AND NORTH AEGEAN SEA

Çetin Keskin [1]*
[1] Fisheries Faculty Istanbul University - aydankeskin10@hotmail.com

Abstract
Fish species richness decreases from the Aegean Sea, Sea of Marmara to Black Sea. In this study, biogeographic differences between three areas were approved in terms of demersal fish species. Some endemic species such as *Mezogobius batrachocephalus* and *Neogobius melanostomus* obtained only less saline and temperate water in the Black Sea.
Keywords: Fishes, Biogeography, Eastern Mediterranean

Introduction
Geologic history and hydrologic characteristics of Turkish Straits System (Bosphorus, Sea of Marmara and Dardanelles) are main factors indicating to the fauna and flora characteristics in the Northeastern Mediterranean from the Aegean Sea to the Black Sea. This system is important as a biological barrier or corridor and acclimatization zone for Mediterranean Sea and Black Sea species [1]. This study is a preliminary emphasis on the zoogeography of demersal fish species in the Black Sea, Sea of Marmara and North Aegean Sea.

Materials and Methods
Fish samples were collected with bottom trawl net. A total of 17 hauls was carried out during autumn periods in 2006 and 2007 on board the R/V *Yunus-S* in the North Aegean Sea (AS), Sea of Marmara (SM) and Black Sea (BS), depth ranging from 22 m to 72 m (Fig. 1). Species presence/absence matrix was used to classify hauls with similar species composition. Cluster based on Bray-Curtis similarity index. SIMPER analysis was applied in order to identify the percentage contribution of each species to the overall similarity.

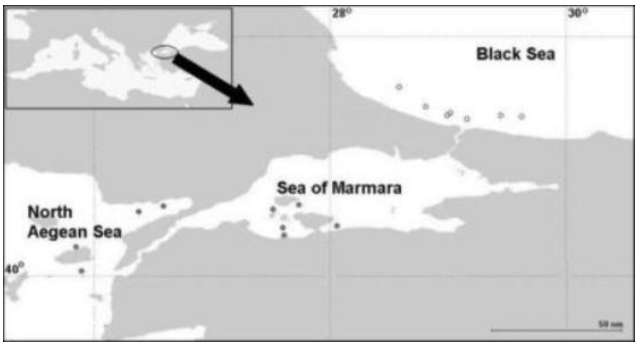


Fig. 1. Samplings in the Black Sea, Sea of Marmara and North Aegean Sea during autumn periods in 2006 (dark circles) and 2007 (white circles).

Results and Discussion
A total of 67 fish species were collected during this study. Species richness showed a decrease from the AS, and SM to BS (38, 30 and 27, respectively). Considering to the zoogeographical origin of the species, there were 55 Atlantic-Mediterranean species, 8 endemic species and 4 cosmopolitan species. The number of endemic species was higher in the BS, the Atlantic-Mediterranean species higher in the AS and SM. Cluster analysis of 17 hauls showed a clear separation according to area (Fig. 2). Samples in the BS separated from in the AS and in the SM at the level of similarity around 18.55%. Samples in the AS separated from the SM at the level of similarity around 51.66%. According to SIMPER results, the average similarity within group AS was 70.90%; *Mullus barbatus, Serranus hepatus, Citharus linguatula, Scyliorhinus canicula, Arnoglossus laterna, Lophius budegassa* and *Serranus cabrilla* were responsible species with high contribution (9.15% each) 50% to the similarity of this group. The average similarity within group SM was 77.07%, and within group 50% similarity was attributed to *Merlangius merlangus euxinus, S. hepatus, Merluccius merluccius, A. laterna, Raja clavata, Chelidonihthys lucernus, M. barbatus* and *Gobius niger* with relatively high contributions each (from 5.22% to 8.69%). The average similarity within group BS was 61.23%, and *Trachinus draco, Scorpaena porcus, M. barbatus, Mezogobius batrachocephalus* and *Neogobius melanostomus* were highly contributing species (from 9.18% to 19.27%) 50% to the similarity of this group. Fish species richness decreases from AS, SM to BS along the Turkish coast [2]. Similar results obtained in this study. Also, the results supported to identification of biogeographically distinct between three areas. Species composition in the BS was highly dissimilar to the species composition in the AS and in the SM. Some endemic species such as *M. batrachocephalus* and *N. melanostomus*, pontian relic species, occurred only less saline and temperate water in the BS, Atlantic-Mediterrenean species such as *C. linguatula, S.hepatus, A. laterna, S. canicula* and *M. merluccius* were common species in the AS and in the SM at least during the sampling period of this study. High similarity between the AS and SM can be explained by the water characteristics of sampling stations in the SM, in which salinity and temperature were more close to the Mediterranean water considering to the depth range (deeper than 40 m). These results support to the separate management plans for demersal fish species in the three areas in terms of ecosystem [3].

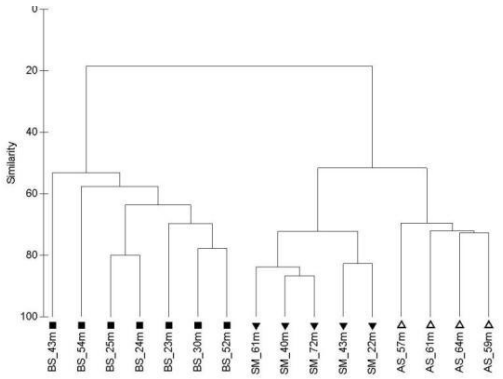


Fig. 2. Dendrogram of similarities for 17 hauls (cluster analysis, group average linkage) sampled during autumn periods in 2006 and 2007.

Acknowledgements: The author wish to thank Prof. Bayram Öztürk for samples from the Black Sea, and all participant in the cruises and TUBITAK (Project No:105Y039) an board R/V Yunus S.

References
1 - Öztürk, B. and Öztürk, A. A., 1996. On the biology of Turkish Strait Systems. *In* Braind F. (ed.), Dynamics of Mediterranean straits and channels. CIESM Science Series No. 2, Bulletin de l'institut oceanographique Monaco (17), pp 205-2179.
2 - Bilecenoglu M., Taskavak E., Mater S. and Kaya M., 2002. Checklist of the marine fishes of Turkey. *Zootaxa* 113, 1-194.
3 - Caddy, J.F., 1998. Issues in the Mediterranean fisheries management: geographical units and effort control. *Stud. Rev.* G.F.C.M., 70: 1-56.

JELLYFISH IN THE NORTHERN ADRIATIC: A 200 YEAR STORY

Tjaša Kogovšek [1]*, Branko Bogunovic [1] and Alenka Malej [1]
[1] Marine Biology Station, National Institute of Biology - kogovsek@mbss.org

Abstract

A 200 year time series of scyphomedusae occurrence in the northern Adriatic was analysed using the wavelet technique to assess the major periodicities. The analysis of the historical time series revealed that four scyphomedusae, *A. aurita*, *C. hysoscella*, *C. tuberculata* and *R. pulmo*, have been present regularly in the northern Adriatic over the last 200 years, with two major periods of jellyfish proliferations. The first period in the years around 1910 was characterised by common significant periodicity of 8 to 12 years. In the second period, from the late 1970's onward, two common periodicities were revealed, those shorter than 8 years and a longer one of 20 - 30 years.

Keywords: Adriatic Sea, Blooms, Cnidaria, Medusae, Time Series

Introduction

In recent years connections between jellyfish blooms and variations in climate have been emphasised ([1], [2]). Very few long-term time series of gelatinous plankton blooms exist due to fragility of these organisms and sampling difficulties. Although large scyphomedusae are generally more rigid than other gelatinous plankton, sampling using conventional oceanographic gears is complicated due to their size [3]. Therefore, most of the data on jellyfish populations are descriptive rather than quantitative, and the problem of choosing a suitable method often arises when analysing time series. Moreover, non-linear, aperiodic and non-stationary processes are very common in nature [4]. This constitutes a limitation when applying most of the analytical techniques for the time series analysis used for detecting periodicity. A powerful tool for analysing such data is wavelet transformation, a time scale and/or time frequency decomposition of the signal useful in analysing the non-stationary, aperiodic and noisy signals that are very often found in ecological time series [5].

Materials and Methods

A data set of the presence/absence of scyphomedusae in the northern Adriatic during the last 200 years was constructed on the basis of 21 papers describing plankton in the northern Adriatic, published over the time span from 1875 till today, in addition to our own (MBS Piran) observations. The constructed time series has been analysed using continuous wavelet analysis [5].

Results

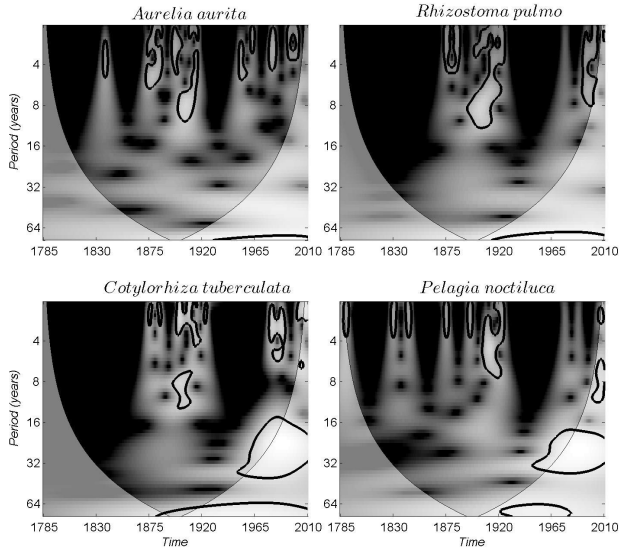


Fig. 1. Wavelet spectra of the four scyphomedusae time series in the northern Adriatic.

Analysis has shown that the five scyphomedusae (*Aurelia aurita* (Linnaeus, 1758), *Chrysaora hysoscella* (Linnaeus, 1766), *Cotylorhiza tuberculata* (Macri, 1778), *Pelagia noctiluca* (Forskål, 1775), and *Rhizostoma pulmo* (Macri, 1778)) have been present regularly in the northern Adriatic over the last 200 years. The most frequently reported scyphomedusae in the northern Adriatic over the whole period of study were *A. aurita* and *R. pulmo*. In the present decade, notably from 2004 onwards, *Aurelia* has been present every year in large numbers from the beginning of February to the end of June, while *Rhizostoma* was the most abundant during 2003 and 2006, after which its numbers decreased significantly. In contrast, *Chrysaora* and *Cotylorhiza* were observed regularly during the last decade but never in high numbers, as blooms were rarely noted. The presence of the latter was regularly reported from the northern Adriatic, mostly from August to September. The presence of holoplanktonic *P. noctiluca* in the northern Adriatic was first recorded in 1790. Between 1976 and 1986 *Pelagia* formed intensive blooms. The population collapsed after spring of 1986 and only appeared again at the beginning of 2004 after an 18 year absence. During the recent bloom, *Pelagia* was most abundant in 2006, more precisely from November 2005 to March 2007.

Although the life cycle, population dynamics and the ability to adapt to different environments differ between the species, the wavelet spectra showed a similar pattern for four meroplanktonic scyphomedusae (*A. aurita, C. hysoscella, C. tuberculata* and *R. pulmo)* with two major periods of jellyfish proliferation in the northern Adriatic during the 200 years. The first period began around 1875 and lasted until 1922, while the second has proceed from the late 1970's onward, following nearly 40 years of almost no jellyfish observations. During the first period of jellyfish proliferation the common periodicity of 8 to 12 years was detected. In contrast, the second period has been characterised by a shorter common periodicity of < 8 years and an additional longer term periodicity of 20-40 years. The latter is significant only in the case of *C. tuberculata* and *P. noctiluca* wavelet spectra. The first period of *Pelagia* proliferations is characterised by a significant periodicity of 8 years and the second period with a significant periodicity between 20 to 30 years.

Conclusions

The analysis of the historical time series revealed that five scyphomedusae, *A. aurita*, *C. hysoscella*, *C. tuberculata*, *P. noctiluca* and *R. pulmo*, have been present regularly in the northern Adriatic over the last 200 years, with two major periods of jellyfish proliferations. The first period is characterised by common significant periodicity of 8 to 12 years and the second period with two common periodicities, one shorter than 8 years and a longer one between 20 and 30 years.

References

1 - Lynam, C. P., S. J. Hay and A. S. Brierley., 2004. Interannual variability in abundances of North Sea jellyfish and links to the North Atlantic Oscillation. *Limnol. Oceanogr*., 49(3): 637-643.

2 - Molinero, J. C., M. Casini and E. Buecher., 2008. The influence of the Atlantic and regional climate variability on the long-term changes in gelatinous carnivore populations in the northwestern Mediterranean. *Limnol. Oceanogr*., 53(4): 1456-1467.

3 - CIESM., 2001. Gelatinous zooplankton outbreaks: theory and practice, *CIESM Workshop Series 14*, Monaco, 112 pp.

4 - Hsieh, C. H., S. M. Glaser, A. J. Lucas and G. Sugihara., 2005. Distinguishing random environmental fluctuations from ecological catastrophes for the North Pacific Ocean. *Nature* 435: 336-340.

5 - Torrence C. and G. P. Compo., 1998. A Practical Guide to Wavelet Analysis. B. *Am. Meteorol. Soc*., 79 (1): 61-78.

REPRODUCTIVE BIOLOGY OF *SQUALUS BLAINVILLEI* (RISSO, 1826) IN THE EASTERN MEDITERRANEAN SEA

Vasiliki Kousteni [1]* and Persefoni Megalofonou [1]
[1] Department of Biology, Section of Zoology-Marine Biology, University of Athens - bkousten@geol.uoa.gr

Abstract
A total of 491 *Squalus blainvillei* were sampled in the Eastern Mediterranean Sea during the period 2004-2009. The overall sex ratio (females:males) was 1.22:1. Females ranged from 321 to 779 mm and males ranged from 272 to 799 in total length. Total length and weight of the specimens were highly correlated (R^2= 0.92). Statistically significant differences were found between females and males in mean GSI and HSI values. Total length at 50% maturity was estimated at 565.3 mm for females and at 457.6 mm for males.
Keywords: Eastern Mediterranean, Fishes, Reproduction

Introduction
Sharks are species particularly vulnerable to the overexploitation because of their k-selected life-history strategy [1]. *Squalus blainvillei* is an ovoviviparous demersal shark distributed in the whole Mediterranean down to about 700 m [2]. Studies on its systematics and biology have been mostly carried out in the Western-Central side [3, 4] while in the Eastern side the knowledge on its population characteristics is still scanty [5]. This study provides preliminary information on the reproductive biology of the longnose spurdog in the Eastern Mediterranean Sea.

Materials and Methods
A total number of 491 *Squalus blainvillei* (269 females, 221 males, 1 hermaphrodite) was obtained from bottom trawl and bottom longline catches from December 2004 to October 2009.
Length and weight measurements were taken and sexual maturity was determined by macroscopic observation of the reproductive organs according to Stehmann [6]. Regression analysis was used to determine length-weight relationship ($Y=aX^b$). Statistically significant differences, between females and males, in length and weight frequency distributions were examined with the Kolmogorov-Smirnov two-sample test. A logistic curve was fitted to the data and the total length at which 50% of individuals are sexually mature was calculated. Gonadosomatic (GSI) and hepatosomatic index (HSI) were determined for each sex. Ovarian fecundity was estimated by the number of ripe oocytes in the ovary of mature females, while uterine fecundity by the number and size of embryos occupying the oviducts.

Results and discussion
Longnose spurdogs ranged from 272 to 799 mm in total length and from 90 to 3079 g in weight (Fig. 2). The overall sex ratio was 1.22:1 (F:M), while among the samples one hermaphrodite was found with internal male reproductive organs and no claspers. Females and males showed statistically significant differences in length and weight frequency distributions (KS test, $P>0.05$).
Out of the specimens examined, 37% of females and 67% of males were sexually mature. The smallest sexually mature female was 523 mm in total length, while the smallest sexually mature male was 403 mm in total length. Mean total length at 50% maturity was estimated at 565.3 mm for females and at 457.6 mm for males [Figure 1].
Gonadosomatic indices reached higher values in females than in males ranging from 0.07 to 14.66 (2.05±2.71) in females and from 0.04 to 2.51 (1.07±0.57) in males. Hepatosomatic index reached higher values in males ranging from 4.41 to 35.78 (10.44±3.61) than in females ranging from 4.55 to 22.86 (11.81±4.06).
Three oocyte stages (ripe, maturing and immature) were identified macroscopically according to its size and colour. Out of 269 females, 44 were found with embryos ranging from 55 to 177 mm in total length. Embryos' length and yolk sac weight were negatively correlated. Both ovarian and uterine fecundity ranged between 1 and 6.

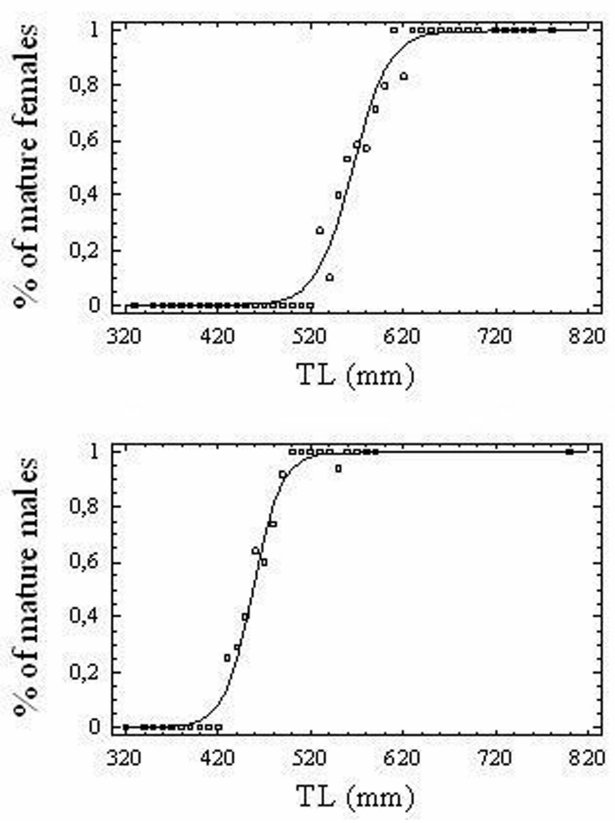


Fig. 1. Total length at 50 % maturity for female and male *Squalus blainvillei*

References
1 - Stevens J.D., Bonfil R., Dulvy N.K. and Walker P.A., 2000. The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems. *ICES,Journal of Marine Science*, 57: 476-494.
2 - Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J. and Tortonese E., 1984. Fishes of the North-Eastern Atlantic and the Mediterranean (FNAM), Vol. 1-3: Unesco, Paris, 1473 p.
3 - Ledoux J.C., 1970. Affiniteés et origins du *Squaus blainvillei* de Mediterranée. *Journal of Ichthyology*, pp.65-69.
4 - Cannizaro L., Rizzo P., Levi D. and Gancitano S., 1995. Age determination and growth of *Squalus blainvillei* (Risso, 1826). *Fisheries Research*, 23: 113-125.
5 - Sion L., D' Onghia G., Matarrese A. and Mytilineou Ch., 2003. First data on distribution and biology of *Squalus blainvillei* (Risso, 1826) from the eastern Mediterranean Sea. *Journal of Northwest Atlantic Fishery Science*, Vol. 31: 210-219.
6 - Stehmann M., 1987. Quick and dirty tabulation of stomach contents and maturity stages for skates, squaloid and other ovoviviparous and viviparous species of sharks. American Elasmobranch Society Newsletter, no.3. pp 5-9.

VARIABLE GROWTH OF BULLET TUNA LARVAE (*AUXIS ROCHEI*) RELATED TO HYDROGRAPHIC SCENARIOS OFF THE BALEARIC SEA

R. Laiz-Carrión [1]*, A. Pérez-Torres [2], J. Quintanilla [1], A. García [1] and F. Alemany [2]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga. 29640 Fuengirola, Málaga. Spain. - raul.laz@ma.ieo.es
[2] Instituto Español de Oceanografía. Centro Oceanográfico de Baleares. 07015 Palma de Mallorca, Islas Baleares, Spain.

Abstract
Biometric differences consequent with variable growth were observed in bullet tuna larvae collected under different hydrographic conditions delimiting water masses of Mediterranean and Atlantic origin. Larger and heavier larvae with higher growth rates were found in the Mediterranean waters together with higher mesozooplankton abundance.
Keywords: Larvae, Growth, Balear Sea

Introduction
Bullet tuna, *Auxis rochei*, represents one of the most abundant small tuna species commercially exploited in the Mediterranean Sea. The high scombroid growth rates at early life stages have been related to high food requirements and environmental conditions [1]. The aim of this study is to corroborate the linkages between hydrographic conditions and food availability with biometric features in bullet tuna larvae collected under specific hydrographic water masses.

Material and Methods
Specimens of early stages of *Auxis rochei* were collected in August 2008 off Mallorca Island (Balearic archipelago, Western Mediterranean), during daytime, by means of oblique tows through the upper mixed layer, above the thermocline. Hauls were performed at a speed of two knots, with Bongo 90 net fitted with 500 mm meshes. A Bongo 20 net, equipped with 100 and 200 mm meshes, was placed 1 m above Bongo 90 frame for mesozooplancton sampling. Some tuna larvae from both 500 mm meshes were sorted on board and stored in liquid nitrogen, whereas the rest was preserved in 96% ethanol (replicate 1) and 2% formaldehyde in seawater (replicate 2). Larvae preserved in ethanol were used for daily growth analysis [2]. Once in laboratory, larvae preserved in N2 were measured and weighed for standard length (SL) and dry weight (DW) determination. Zooplankton biomass for the size fractions 100-250 µm and >250 µm was determined drying the samples to a constant weight, and referred to the volume of filtered water (mg/m^3). Hydrographic data were collected at each sampling station using a CTD profiler. A principal component analysis (PCA) was carried out to characterize different stations in relation to environmental features (86.6 % representation). To run this PCA, mean temperature (T), salinity (S) and oxygen (O) in first 5 m, were selected after linear correlations between variables were performed.

Results and Discussion
The different stations were grouped in two classes according to the PCA analysis of the hydrographic conditions: group A, characterized by higher T and S values, and group B with lower T and S values. Both groups represent Mediterranean (MW) and Atlantic (AW) waters respectively [3] (Fig. 1).

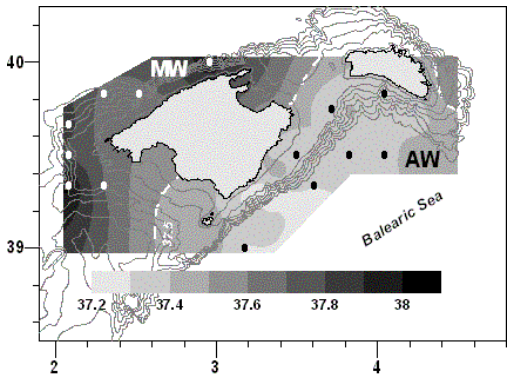


Fig. 1. Stations sampling distribution according to the PCA analysis in the study area. Mediterranean-MW (white) and Atlantic-AW (black) overlapped to salinity contours.

The SL and DW ANOVA analysis between groups shows significantly larger (p<0.001) and fatter (p=0.002) bullet tuna larvae located in MW (7 stations, 47 larvae, mean SL 7.1 mm and mean DW 0.58 mg) with respect to the AW (7 stations, 49 larvae, mean SL 6.0 mm and mean DW 0.28 mg). These differences are not merely attributable to differences in larval ages distribution; but to higher growth rates (ANCOVA $F_{1, 57}$=7.16, p=0.01) in the larvae inhabiting MW (Fig. 2), which is in agreement with higher Fulton's condition factor in MW larvae (0.137) than in AW ones (0.101) (p=0.006).

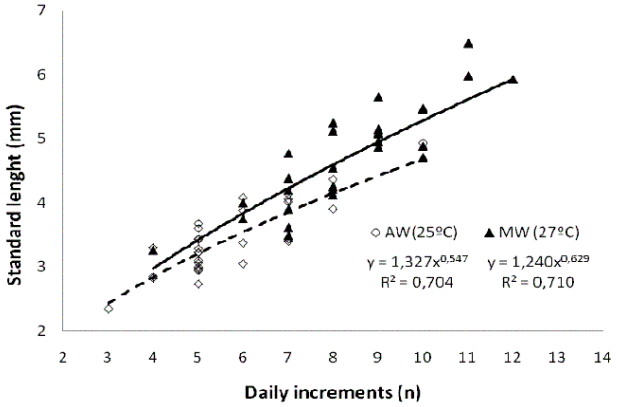


Fig. 2. Daily growth for bullet tuna larvae in both AW and MW.

These differences are partly due to higher temperatures of MW waters [4]; but could be also a result of higher availability of larger preys, which according to previous studies constitute the major dietary component [5], since size fractioned zooplankton analysis revealed a 7-fold greater biomass (p<0.001) in the fraction >250 µm in MW stations. Moreover, recent studies have shown that the probability of finding bullet tuna larvae increases with higher mesozooplankton biomass (>200 µm) [6].

References
1 - Catalán I.A., Alemany F., Morillas A. and Morales-Nin B., 2007. Diet of larval albacore *Thunnus alalunga* (Bonnaterre, 1788) off Mallorca Island (NW Mediterranean). *Scientia Marina* 71(2): 347-354.
2 - García, A., Cortés D., Ramírez T., Fehri-Bedoui R., Alemany F., Rodríguez J.M., Carpena A. and Alvarez J.P., 2006. First data on growth and nucleic acid and protein content of field-captured Mediterranean bluefin (*Thunnus thynnus*) and albacore (*Thunnus alalunga*) tuna larvae: a comparative study. *Scientia Marina* 70S2: 67-78.
3 - López-Jurado J.L., J. Garcia Lafuente and Cano. N., 1995. Hydrographic conditions of the Ibiza Channel during november 1990, March 1991, July 1992. *Oceanol. Acta*, 18(2): 235 – 243.
4 - Pérez-Torres A., Alemany F., and Reglero P., 2009. Effect of environmental variability on the distribution, abundances and growth rates of the larvae of bullet tuna. *ICES CM 2009*/G:17 Poster.
5 - Morote E., Olivar M.P., Pankhurst P.M., Villate F. and Uriarte I., 2008. Trophic ecology of bullet tuna *Auxis rochei* larvae and ontogeny of feeding-related organs. *Marine Ecology Progress Series* 353: 243–254.
6 - Reglero P., Urtizberea A., Fiksen Ø., Catalán I.A., Pérez-Torres A., Alemany F., 2009. Size dependent predation in piscivorous larval stages of three tuna species. *ICES CM 2009*/T:12.

MARINE BIODIVERSITY AND FISHERY RESOURCES IN SYRO-LEBANESE COASTAL WATERS (LEVANTINE BASIN)

Sami Lakkis [1]* and Waad Sabour [2]
[1] Dept. of Biology, Lebanese University, Beirut, Lebanon. - slakkis@ul.edu.lb
[2] Dept. of Zoology, Faculty of Science, Tishreen University, Lattakia , Syria.

Abstract
A study on fish food and feeding regime was carried out during 2004-2008 in adjacent Syrian and Lebanese coastal water. Stomach and intestine content analysis was conducted on one selected fish herbivorous, carnivorous and omnivorous in order to study the nature and composition of the food as related o fish resources. Herbivorous rabbit fish(*Siganus rivulatus)* feed on available chlorophytes, phaeophytes and rhodophytes algae, whereas demersal carnivorous grouper (*Epinephelus marginatus)* feed on small fishes, cephalopods and crustaceans.Pelagicsardine ***(****Sardinella aurita)* and anchovy *(Engraulis encrasicolus)* are mostly planktonivorous. Benthic *Solea vulgaris* is a carnivorous regime feeding on benthic invertebrates including meiofauna..
Keywords: Biodiversity, Fish Behaviour, Fishes, Levantine Basin

Introduction
Adjacent Lebanese and Syrian seawaters show similar oceanographic characteristics and both of regions present oligotrophic water body inducing low primary productivity and thus poor fish production. In spite of high marine biodiversity and good fish resources, fishing landing remain in deficit. Data on the major flora and fauna are available[1], but the information remain incomplete with regard to the relation between fish resources and marine biodiversity. Based on the knowledge and data available with regard to the composition and abundance of marine flora and fauna of the local coastal, the study of fish food and feeding regime would be easier and reachable. In previous study we attempt to study the diet of some fish species [2]. In this paper an attempt is made to study the diet and feeding regime of some species representing herbivorous, carnivorous and planktonivorous fish and correlated between fishery resources, feeding regime and marine biodiversity.

Methods and Material
Stomach and intestine content analysis was performed on freshly caught fish specimens from different regions of Syrian and Lebanese coastal waters. Hydrological parameters including temperature, salinity, nutrient and chlorophyll.a were taken at the same fishing areas. Information regarding the biodiversity of pelagic, benthic and littoral flora and fauna in the same sampling zone, are available from previous works [3,4,5,6] The selected species subject to food and feeding regime study are: carnivorous *Epinephelus marginatus*, planktonivore *Sardinella aurita*, herbivorous *Siganus rivulatus* and benthic *Solea vulgaris.*

Results and Discussion
The adjacent Lebanese and Syrian coastal waters show similar oceanographic characteristics and mostly the same habitats. Furthermore, certain homogeneity in the biodiversity of flora and fauna is observed and thus a resemblance in fishery resources between the two marine regions. Marine flora and fauna of the Syro-Lebanese coastal waters are highly diversified; most of the Mediterranean groups are found in the area. In addition to those, several species of Indo-Pacific origin, including fishes, were introduced or have migrated from the Red Sea into the Levantine Basin, where many invaders have established permanent populations.The composition of the food in the intestine of *Epinephelus marginatus* is formed with pieces of small fishes of *Scorpaena., Epinephelus, Trigla, Serranu, Mullus, Diplodus, Sparus, Pagellus,Coris julis, Gobius, Blennius, Solea, Venus,,Conus, Cardium, Sepia officinalis,Octopus vulgaris*, Penaeus,, *Scyllarus, Palaemonidae, Asterina, Asterina, Polychaetes* etc. Herbivorous rabbit fish *Siganus rivulatus which* is an invading tropical species in the area; it is very abundant in the near coastal water. It feeds all the time without discontinuity, even during the reproduction and spawning periods in spring. The composition of the food in the stomach and intestine of the rabbit fish is formed with pieces of macroalagae from Rhodophytes (*Porphyra, Corallina, Galaxaura, Amphiroa rigida, Ceramium, Hypnea, Jania rubens*), Chlorphytesfrom genera *Ulva, Enteromorpha,Cladophra, Codium, Phaeophytes (Padina pavonica , Sargassum vulgare, Dictyopteris* , etc.. Planktonivore fish *Sardinella aurita* feed mostly on phytoplankton and zooplankton. This pelagic fish is present in our waters only during the spawning periods between May and July. The digestive tube content reveals the presence of debris of diatoms from *Chaetoceros, Coscinodiscus, Bacteriastrum, Rhizosolenia*, and dinoflagellates such as: *Ceratium,Dinophysis, Protoperidinium, Ornithocercus*, and pieces of microzooplankton (*Codonella, Codonella, Eutintinnus,Globigerina*). From macrozooplankton we distinguish in the digestive tube *Sagitta, Copepods, Cladocera, Polychaeta, Pteropods, Fish larvae*, etc. Benthic flat fish *Solea vulgaris* live on the sandy seafloor; it swim with difficulty and move very slowly above the bottom. The fishing yield of this species is poor may be because of the lack of appropriate fishing gear and the limited fishing ground. The stomach content reveals the presence of benthic invertebrates such as: mollusks, crustaceans, varied meiofauna; we also distinguish benthic algae namely *Caulerpa*, and phanerogams *Zostera* and *Cymodocea*. Fishing activity tends to reduce natural fish stock; in which a big amount is caught according to its abundance and the fishing effort. Other factors might also affect the fish stock such as anthropogenic activity and overfishing which contribute to reducing fisheries and fishing yield. Some species constitute target to fishermen, particularly during reproduction and sexual maturity and before spawning; this can lead, to the deterioration and collapse of the stock.

References
1 - Lakkis S., 1985. "Sur un Projet d'Etablissement d'un Parc Marin dans les îles du Palmier, au nord du Liban: Aspects écologiques et Maritimes ". Atti del Convegno internazionale I Parchi Costieri Mediterranei, Salerno Castellabate, Italia, 18-22 giugno 1973: 473-484.
2 - Lakkis S., 1973. Projet d'Etablissement d'une zone protégée dans les îles des Palmiers, au nord du Liban: Aspects écologiques. Conference internationale pour la protection de la mer Méditerranée contre la pollution. Charte de Beyrouth, Principes de Base: 63-65.
3 - Tohmé G, 1973. Projet d'Etablissement d'une zone biologique protégée dans les îles des Palmiers, Tripoli, Liban". Conference internationale pour la protection de la mer Mediterranée contre la pollution. Charte de Beyrouth, Principes de Base: 67-68.
4 - Lakkis, S., Bitar,G.,Novel-Lakkis,V.and Zeidane R., 1996. "Etude de la Diversité Biologique Liban. Flore et Faune Marines " . UNEP & Min. Agric. Beyrouth, Liban, Publ. No 6: 123p.
5 - Lakkis S. and Novel-Lakkis V., 1981. Composition, annual cycle and species diversity of the Pytoplankton in Lebanese coastal water". *Journal of Plankton Research* 3, 1: 123-136.
6 - Lakkis S. & V.Novel-Lakkis., 2000. Distribution of the Phytobenthos along the coast of Lebanon (East Mediterranean). *Medit. Mar. Sci.*,1/2: 143-164.
7 - Mouneimné N., 1978. "Poissons des côtes du Liban (Méditerranée orientale) Biologie et Pêche ".Thèse Doctorat ès-Sciences. Université Paris 6: 416 p.
8 - Bitar,G., 1996. "Le Macrozooplankton" in: Etude de la Diversité Biologique du Liban Flore et Faune Marines.Lakkis (eds) .UNEP Min. Agric. Beyrouth, Liban, Publ. No 6: 113-125.
9 - Abu-Ezzeddine, F., P. Hitchcock, L.Yamout, Jaradi G., 2000. "Palm islands Nature Reserve; Protected Area Project,Management plan". Ministry of Environment, Lebanon.

CROISSANCE ET REPRODUCTION DU ROUGET BARBET DE ROCHE (*MULLUS SURMULETUS* L. 1758) DANS LA BAIE DE M'DIQ (MAROC)

Abdeljaouad Lamrini [1]*

[1] Institut Agronomique et Vétérinaire Hassan II, Rabat, 10101, Maroc - a.lamrini@iav.ac.ma

Abstract

Les rougets provenant de la baie sont âgés de 1 à 9 ans (12 - 30 cm). Les paramètres de croissance sont LTinf = 313,4 mm ; K = 0,6 ; t_0 = -0,46 ; Winf = 283 g avec des niveaux plus élevés pour les femelles. Le sex-ratio est en faveur de celles-ci (61,3%), la taille de 1re maturité est atteinte à 167 mm pour les mâles et 178 mm pour les femelles (≈2ans). La période de reproduction se situe de mai à juillet. Ces résultats sont plus proches de ceux des autres côtes occidentales méditerranéennes que ceux des côtes de la Méditerranée centrale et orientale.

Keywords: Growth, Reproduction, Western Mediterranean, Fishes, Demersal

Les études relatives à la biologie du rouget barbet de roche (*Mullus surmuletus* L. 1758) en Méditerranée marocaine font défaut surtout dans sa partie occidentale. Ce travail est une contribution à l'étude de sa croissance et de sa reproduction dans la baie de M'diq.

Matériel et Méthodes

292 poissons analysés de février à juillet 2009 ont été échantillonnés (25 individus chaque quinzaine) à partir des prises commerciales des chalutiers fréquentant la baie de M'diq. Après avoir procédé aux mensurations et pesées (tailles et poids des poissons, poids des gonades et du foie), détermination du sexe et stades de maturité, prélèvements (otolithes, fragments de gonades), l'âge a été déterminé par otolimétrie. La clé âge longueur et les croissances, linéaire et pondérale, ont été établies (Modèle de Von Bertalanffy et relations taille poids). Les paramètres de croissance ont été estimés par le logiciel Fishparm. Le sex-ratio et la taille de 1re maturité ont été déterminés. La période de reproduction a été délimitée par examen dans le temps des rapports gonadosomatique (RGS) et hépatosomatique (RHS) ainsi que sur les observations macroscopiques et histologiques des gonades.

Résultats et Discussion

Seules 227 paires d'otolithes (77,74 %) ont permis une détermination des âges compris entre 1 et 9 ans. La clé âge longueur montre que les poissons ont des tailles comprises entre 12 et 30 cm avec une dominance de 15 à 21 cm (2 à 5 ans). La longévité des femelles peut atteindre 9 ans alors que celle des mâles 7 ans. Les équations de croissance linéaire obtenues sont :

Mâles : $Lt = 30,25\ [1 - e^{-0,52(t+0,16)}]$;

Femelles : $Lt = 32,26\ [1 - e^{-0,54(t+0,62)}]$;

Sexes confondus : $Lt = 31,34\ [1 - e^{-0,60(t+0,46)}]$.

Les relations taille poids ont été établies afin de pouvoir déduire les équations de croissance pondérale à partir des équations ci-dessous :

Mâles : $Wt = 4,75.10^{-3}Lt^{3,1846} \Rightarrow Wt = 242,80\ [1 - e^{-0,52(t+0,16)}]^{3,1846}$

Femelles : $Wt = 4,16.10^{-3}Lt^{3,2506} \Rightarrow Wt = 317,05\ [1 - e^{-0,54(t+0,62)}]^{3,2506}$

Sexes confondus : $Wt = 4,14.10^{-3}Lt^{3,2504} \Rightarrow Wt = 283,00\ [1- e^{-0,60(t+0,46)}]^{3,2504}$

Les résultats sont très proches de ceux obtenus en Espagne [1] et en Tunisie [2], alors qu'ils sont assez éloignés de ceux trouvés en Italie [3], ce qui est dû à un environnement différent. Le sex-ratio est en faveur des femelles (61,3%), les mâles montrent une abondance dans les petites tailles à l'inverse des femelles qui abondent dans les grandes tailles, devenant exclusives à partir de 24 cm. Ce résultat est imputable à un taux élevé de masculinité à la naissance, une mortalité plus élevée chez les mâles, une longévité plus grande des femelles ou encore une croissance différentielle entre les deux sexes. La maturité sexuelle a été appréciée par les observations macroscopiques et microscopiques des gonades permettant de distinguer les stades classiques. Elle se produit à 178 mm pour les femelles et 167 mm pour les mâles, ce qui correspond à un âge de 2 ans. Ces résultats sont proches de ceux obtenus en Atlantique Nord-est [4] alors qu'ils sont assez différents de ceux de la Méditerranée et ceux obtenus à Majorque [5]. Le suivi mensuel du RGS, du RHS et des différents stades de maturité sexuelle ainsi que l'étude histologique des gonades ont permis de situer la période de ponte entre mai et juillet ; c'est le cas de la majorité des zones méditerranéennes [6] et atlantiques Nord-est [4], [7], sauf sur les côtes tunisiennes et égyptiennes [8] où l'espèce se reproduit entre avril et mai.

References

1 - Sanchez, P., Alvarez, F., de Ramen, S.and Sartor, P., 1995. Evaluation and analysis of the interactionof fishing gears in the demersal fisheries of Western Mediterranean. Final Report. Ec. Research Programme Studies in the Fishing Sector. MED9/009, 333p.

2 - Jabeur, C., Missaoui, H., Gharbi, H. and El Abed, A., 2000. La croissance du rouget rouge (*Mullus surmuletus* L. 1758) dans le golfe de Gabès. *Bull. Inst. Nat. Scient. Tech. Mer de Salammbô*, 27: 35-43.

3 - Andaloro, F. et Giarritta, S.P., 1985. Contribution to tht knowledge of the age and growth of striped mullet (*Mullus barbatus* L. 1758) and red mullet (*Mullus surmuletus* L. 1758) in the Sicilian Channel. GFCM. Report of the Second Technical Consultation on Stock Assessment in the Central Mediterranean, Mazara Del Vallo, Italy, 136: 89-92.

4 - Desbrosses, P., 1936. Contribution à la connaissance de la biologie du rouget barbet en Atlantique nord (IV). *Rev. Trav. Inst. Scient.Tech. Pêche Marit..*, 92: 329-399.

5 - Renones, O., Massuti, E. and Morales-Nin, B., 1995. Life history of the red mullet (*Mullus surmuletus*) from the bottom-trawl fishery of the Island of Majorca (North-west Mediterranean). *Mar. Biol.*, 123 (3): 411-419.

6 - Lalami, T.R. 1971. Contribution à l'étude systématique, biologique, écologique et statistique des poissons de la pêcherie d'Alger. *Bull. Inst. Océanogr. Alger, 3 (4) : 1-150*

7 - N'Da, K., 1992. Biologie du rouget de roche *Mullus surmuletus* (Poisson Mullidae) dans le nord du golfe de Gascogne : reproducteurs, larves et juvéniles. Thèse de 3ème Cycle. Brest, Université de Bretagne Occidentale (UBO), 177p.

8 - Hashem, M.T., 1973a. Some biological studies on the goath fish (*Mullus surmuletus* L.) in the Egyptian Mediterranean waters. *Bull. Inst. Océanogr. Fish.*, 13: 78p.

DEMOGRAPHIE, EXPLOITATION ET ETAT DES STOCKS DU ROUGET BARBET DE ROCHE (MULLUS SURMULETUS, L.1758) DANS LA BAIE DE M'DIQ (COTE OCCIDENTALE DU MAROC)

Abdeljaouad Lamrini [1]*

[1] Institut Agronomique et Vétérinaire Hassan II, Rabat, 10101, Maroc - a.lamrini@iav.ac.ma

Abstract

La pêche du rouget s'effectue au nord du port de M'diq à 45-65 m sur fonds rocheux et sableux ; elle oscille autour de 40 t/an, soit 4 à 5% des débarquements de cette espèce à l'échelle nationale. Les prises se composent de 3 à 4 cohortes, mais ce sont les juvéniles et les tailles moyennes qui sont les plus exploités. La taille de 1re capture est de 15,2 cm. Les mortalités, totales, naturelles et par pêche, s'élèvent respectivement à 1,25 - 0,75 - 0,5, alors que le taux d'exploitation est de l'ordre de 0,4 ; il s'agirait d'un bon état d'exploitation.

Keywords: Western Mediterranean, Fisheries, Demersal, Stock Assessment, Fishes

Introduction

La situation des stocks du rouget barbet de roche (*Mullus surmuletus* L. 1758) en Méditerranée marocaine est méconnue surtout dans sa partie occidentale. Ce travail contribue à l'étude de sa démographie, son exploitation et l'état de ses stocks dans la baie de M'diq.

Matériel et Méthodes

Pour faire une étude démographique, 2 275 rougets, pêchés de février à juillet 2009, ont été échantillonnés (une à deux caisses chaque quinzaine) à partir des prises commerciales des chalutiers fréquentant la baie de M'diq. Après avoir établi les distributions de fréquence de tailles mensuelles, leur décomposition a été réalisée par la méthode de Bhattacharya [1], ce qui a permis d'apprécier l'importance des différentes cohortes composant le stock et leurs variations au cours de la période d'étude.

L'exploitation a été appréhendée par enquête auprès des principaux patrons de chalutiers fréquentant la baie pour déterminer les zones de pêche et par examen des statistiques de capture entre 2003 et 2008 pour apprécier l'importance des débarquements.

L'état des stocks a été étudié par la méthode de Beverton et Holt [2] en passant par la détermination de la taille à la 1re capture (Lc) et en estimant les différents taux de mortalité (totale : Z, naturelle : M et par pêche : F).

Lc a été déterminée par la méthode de Caddy [3], Z a été calculé par la méthode de Beverton et Holt faisant intervenir Lc et Lm (taille moyenne de l'échantillon) ainsi que K, Linf (paramètres de l'équation de Von Bertalanffy) établis dans un autre article de ce volume [8] ; la relation pour le calcul de M est:

Log M = - 0,0066 – 0,279 Log Linf + 0,6543 Log K + 0,4634 Log T° [4]

T° est la température moyenne annuelle de l'eau où séjourne le stock étudié (19°9 - 21°2 C)

La mortalité par pêche est déduite des deux autres (Z – M). Le taux d'exploitation E définit la proportion du stock prise par pêche [5]. Le stock est équilibré lorsque la prise potentielle est optimisée avec l'égalité entre M et F [6] avec E voisin de 0,5.

Résultats et Discussion

Cinq zones de pêche éloignées au nord du port de M'diq de 3 à 10 miles, sont fréquentées à des profondeurs rocheuses et sableuses de 45 à 65 m (Oued Smir, Restinga, Oued Negro, El canto et Snasel).

Les débarquements annuels fluctuent entre 27 et 47 tonnes environ avec une tendance à la baisse. Ils représentent 4 à 5% des prises à l'échelle nationale (méditerranéenne et atlantique). Au cours de l'année, le maximum est enregistré en automne et le minimum en été.

L'analyse modale des distributions de fréquences de tailles mensuelles permet de distinguer trois à quatre cohortes chaque mois durant la période d'étude. La 1re et la 2e cohorte sont les plus représentées en raison de la fréquentation importante des petits fonds côtiers par les chalutiers ; ce sont les juvéniles et les tailles moyennes qui sont les plus exploités.

Le suivi mensuel des différentes cohortes montre que la 1re (14-18 cm) apparaît chaque mois avec un pourcentage variable (49,6-8,04%), la 2e (17-22 cm) est représentée par un pourcentage relativement fixe (29-40%) durant la période d'étude, la 3e (21-26 cm) montre une tendance à la chute d'un mois à l'autre (33,3% en février, 11% en juin), alors que la 4e cohorte (26-28 cm) n'apparaît qu'à partir de mars avec une faible proportion (5,6-10%).

La taille à la 1re capture correspond à 15,2 cm. Les mortalités, totale, naturelle et par pêche, sont estimées respectivement à 1,25 - 0,75 - 0,5 alors que le taux d'exploitation est évalué à 0,4. La mortalité totale mensuelle est relativement stable durant février, mars et avril (0,96 - 1,03) alors qu'elle augmente durant les mois suivants (1,38 - 1,59) coïncidant avec la période de reproduction durant laquelle les géniteurs sont en état d'épuisement.

La mortalité naturelle (0,75) est située dans la fourchette conventionnelle (0,5 - 1). Le taux d'exploitation laisse présager que le stock du rouget de roche serait bon. Cependant, ces résultats restent approximatifs en l'absence de statistiques fiables sur plusieurs années (effort de pêche, captures, …) permettant de calculer directement les différents taux.

References

1 - Bhattacharya, C.G., 1967. A simple method of resolution of a distribution into Gaussian components. *Biometrics*, 23 (1): 115-135.

2 - Beverton, R.J.H. and Holt, S.J., 1966. Manuel of methods for fish stock assessment, Part. II. Tables of yield functions. F.A.O. Fish. Tech. Pap. 38 (Rev. 1), 10p.

3 - Caddy, J.F., 1981. Report of the second technical consultation on stock assessment in the Balearic and Golf of Lion; statistical divisions. F.A.O. Fish. Rep. 263: 133-134.

4 - Pauly, D., 1978. A discussion of the potential use in population dynamics of the interrelation ship between natural mortality, growth parameters, and mean environmental temperature in 122 stocks. ICES. CM. 1978/G-21, 35p.

5 - Pauly, D., 1983. Some simple methods for the assessment of tropical fish stocks. FAO. Fish. Tech. Rep., 234, 52p.

6 - Gulland, J., 1971. Population dynamics of world fisheries. Univ. of Washington, Seattle, USA, 336p, mimeo.

7 - Comité des pêches pour l'Atlantique centre est (COPACE)., 1971. Rapport de la deuxième session du groupe de travail sur les mesures de réglementation des stocks démersaux. Rome, 22-26 mars 1971, FAO. Rapp. Pêches, 109, 112p.

8 - Lamrini A., Démographie, exploitation et état des stocks du rouget barbet de roche (mullus barbatus, l. 1758) dans la baie de M'diq (côte occidentale du Maroc), 39e congrès de la CIESM, ce volume.

GENETIC SUBDIVISIONS OF THE RED CORAL (*CORALLIUM RUBRUM*) IN THE MEDITERRANEAN SEA : EVOLUTIONARY HISTORY AND MANAGEMENT IMPLICATIONS

J. B. Ledoux [1]*, D. Aurelle [1], K. Mokhtar-jamaï [1], A. Chenuil [1], J. Garrabou [2] and J. P. Féral [1]
[1] Aix-Marseille Université Centre d'Océanologie de Marseille, UMR 6540 DIMAR CNRS - jean-baptiste.ledoux@univmed.fr
[2] Institut de Ciencies del Mar-CSIC

Abstract
The genetic structure of the red coral *Corallium rubrum* was analysed in the Western Mediterranean. A clustering analysis identified six genetic groups and evidenced the particular genetic characteristics of Adriatic and North African populations. These data are useful for the management of this harvested species.
Keywords: Genetics, Cnidaria, Western Mediterranean

Introduction:
The management and protection of biodiversity require an analysis of populations structure and connectivity. In the marine environment direct estimation of species dispersal abilities is difficult. Indirect estimates of dispersal can be obtained through genetic data [1]. In the Mediterranean Sea several genetic breaks common to different species have been identified [2] which may define the limits of conservation units [3]. Nevertheless few studies considered samples from Southern Mediterranean (North Africa) whereas a North-South distinction may be observed [4]. The red coral *Corallium rubrum* is an emblematic and harvested species also threatened by climate change [5], [6]. Previous studies indicated genetic differentiation at short distances with several genetic groupings at higher distances [7], [8]; up to now no study included North-African samples.

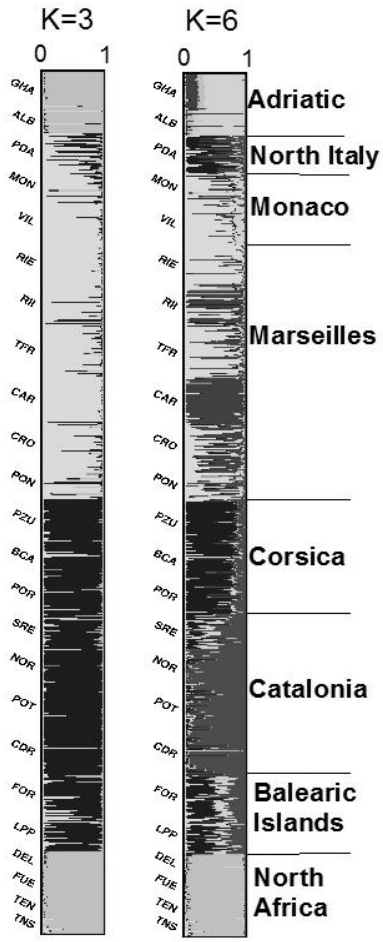


Fig. 1. Clustering analysis: each vertical line corresponds to one individual with colors indicating the assignment score (0 to 1) in each group

Material and Methods:
We applied seven microsatellites loci [8] to 24 populations representing different regions of the Mediterranean distribution area of this species including Adriatic Sea and North Africa (Morocco and Algeria). A bayesian clustering analysis [9] was used for the identification of different genetic clusters. An Analysis of Molecular Variance (AMOVA) allowed to test genetic differentiation between the obtained clusters.

Discussion:
The clustering analysis are presented in Fig.1 for the retained solutions (K=3 and 6 groups). The clusters correspond to the main geographical subdivisions and are genetically differentiated ($p<0.001$). Our results confirm the already observed geographical structuring [8] and extend these data with the differenciation of Adriatic samples (a single population analysed before, [7]) and North African samples. Nuclear sequence data suggest a low divergence among these groups [10] and a lack of long term isolation. The North African samples indicate that this area may be a important component of genetic diversity and would deserve more collaborative studies. According to these data the management of this species should take into account these differences at a regional but also a local scale [8].

References
1 - Féral J.-P., 2002. How useful are the genetic markers in attempts to understand and manage biodiversity? *J. Exp. Mar. Biol. Ecol.*, 268: 121-145.
2 - Borsa P., Naciri M., Bahri L., et al., 1997. Intraspecific zoogeography of the Mediterranean: population genetic analysis on sixteen atlanto-mediterranean species (fish and invertebrates). *Vie Milieu*, 47, 295–305.
3 - Paslbøll P.J., Bérubé M., Allendorf F.W., 2007. Identification of management units using population genetic data. *Trends Ecol. Evol.*, 22(1): 11-16.
4 - Chaoui L., Kara M.H., Quignard J.-P., et al., 2009. *C. R. Biol.*, 332: 329–335.
5 - Santangelo G., Bramanti L., Iannelli M., 2007. Population dynamics and conservation biology of the over-exploited Mediterranean red coral. *J. Theor. Biol.*, 244: 416–423.
6 - Garrabou J., Coma R., Bensoussan N., et al., 2009. Mass mortality in Northwestern Mediterranean rocky benthic communities: effects of the 2003 heat wave. *Glob. Change Biol.*, 15(5): 1090-1103.
7 - Costantini F., Fauvelot C., Abbiati M., 2007. Genetic structuring of the temperate gorgonian coral (*Corallium rubrum*) across the western Mediterranean Sea revealed by microsatellites and nuclear sequences. *Mol. Ecol.*, 16: 5168–5182.
8 - Ledoux J.-B., Mokhtar-Jamaï K., Roby C., et al., submitted.
9 - Pritchard J.K., Stephens M., Donnelly P., 2000. Inference of Population Structure Using Multilocus Genotype Data. *Genetics*, 155: 945-959.
10 - Mokhtar-Jamaï K., Ledoux J.-B., Garrabou J., et al., 2009. Interest and application of genetic markers for the study and conservation of mediterranean sessile invertebrates. Proceedings of the 1st Mediterranean symposium on the conservation of the coralligenous and other calcareous bio-concretions. C. Pergent-Martini & M. Brichet edits., RAC/SPA publ., Tunis : 273p.

EXPERIMENTAL APPROACH TO THE POTENTIAL RESPONSE OF A LONG-LIVED INVERTEBRATE SPECIES FACING THE WARMING IN THE NW MEDITERRANEAN

J. Ledoux [1]*, D. Aurelle [1], J. P. Feral [1], J. Garrabou [2] and C. Marschal [1]
[1] Aix-Marseille Université, Centre d'Océanologie de Marseille – CNRS UMR 6540 DIMAR - jean-baptiste.ledoux@univmed.fr
[2] Institut de Ciencies del Mar-CSIC

Abstract
The precious Mediterranean red coral *Corallium rubrum* is a colonial and aposymbiotic octocorallian characterized by low dynamics and limited dispersal ability. Recently, shallow populations of this species were differentially affected by positive thermal anomalies possibly related to global warming. The question of differential individuals fitness in front of this new environmental disturbance arises. As a first step, we choose to study the relationship between these organisms and their local environment. Populations dwelling in contrasted temperature regimes (i.e.; warm and variable vs. cold and more stable) were reciprocally transplanted. The individuals' fitness was evaluated through the measurement of growth during 6 months including the summer period. These results are discussed in the light of population genetic structure.
Keywords: Genetics, Global Change, Conservation, Mortality

The study of the underlying ecological and/or genetic factors involved in the differential responses of populations to temperature anomalies is a key issue to better understand the impact of the ongoing climate change in the rich Mediterranean communities. This require among other things, the analysis of the degree of adaptation of populations to their local environment (i.e. local adaptation). The different responses observed at the population level during recent mass mortality events (MME) could reflect different levels of thermotolerance [1] that could be linked to different adaptation to local thermal regimes. We conducted reciprocal transplants experiments to test for local adaptation. The Mediterranean red coral *Corallium rubrum* was used as a model species. Reciprocal transplants of colonies dwelling at 20 m (shallow habitat) and 40m depth (deep habitat) were carried out at two regions (Riou Archipelago (Marseille) and Scandola (Corsica). Contrasted temperature conditions characterize shallow (warm and variable regime) and deep (cold and stable regime) habitats. Colonies were transplanted into experimental plates and labelled with calceine at the beginning of the experiment (spring 2006) for about a 6 month period (Fig 1A).

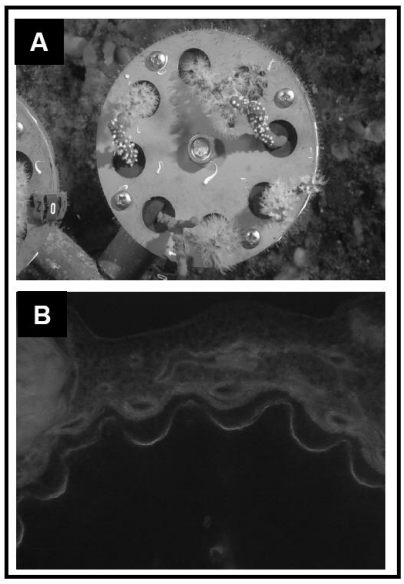


Fig. 1. **A.** Transplant plates used for the reciprocal transplant experiment in 2006, Riou Sud 20m. **B**. Stereomicroscope image showing the calceine labelling in a transplanted red coral colony

Growth rate during the transplant period was used to estimate the relative fitness value (Fig 1B). Only the population from Riou Sud 20 m showed significant decrease in growth rate when transplanted to 40m (from 0.10 mm to 0.04 mm over the 6 month period) (Fig 2).

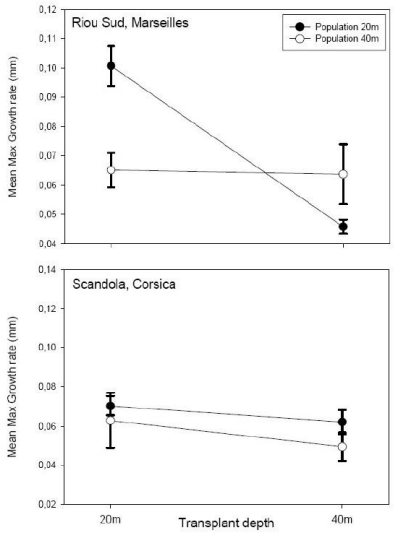


Fig. 2. Mean maximum growth rates (mm) from the transplanted colonies in different depths (20-40 m) in the two regions studied (Marseilles and Corsica)

All other populations tested did not show significant differences between treatments. Genetic analysis based on 10 microsatellites showed significant structure between populations. Therefore, we conclude that different genotype*environment interactions exist in the studied populations. This result is an important step in the characterization of the local adaptation in the populations of *C. rubrum*.

References
1 - Garrabou J., Coma R., Bally M., Bensoussan N., et al., 2009. Mass mortality in northwestern Mediterranean rocky benthic communities : effects of the 2003 heat wave. *Global Change Biology*, 15: 1090-1103.

LESSEPSIAN FISH MIGRANTS IN THE HELLENIC SEAS: SPATIAL VARIATION OF THEIR OCCURRENCE IN BOAT-SEINE CATCHES

E. Lefkaditou [1]*, M. V. Segovia [2], G. Petrakis [1], S. Kavadas [1] and G. Christides [1]
[1] Institute of Marine Biological Resources, Hellenic Centre for Marine Research - teuthis@ath.hcmr.gr
[2] Department of Hydrobiology abd Ecology, University of Murcia, Spain

Abstract
Seven Lessepsian fish species, *Etrumeusteres, Fistulariacommersoni, Lagocephalusscleratus, Pteragogus pelycus, Siganus luridus, Siganus rivulatus* and *Stefanolepis diaspros*, have been identified in boat-seine catches at depths 11-54 m in the Hellenic Seas from October 2008 to March 2009. The frequency of Lessepsian fish's occurrence in boat-seine hauls tended to decrease from southeastern to northern and western Aegean Sea, while it was generally increasing proportionally to the number of years since each species entry in the Hellenic waters.
Keywords: Aegean Sea, Ionian Sea, Fishes, Lessepsian migration, Coastal Waters

Introduction
Fish species of Indo-Pacific Ocean origin have been reported from the Hellenic Seas since the early 1930's, their findings and expansion being accelerating in recent years [1]. The majority of the 29 up to date Lessepsian fish migrants [2, 3], are neritic species caught down to 68 m [1], usually by artisanal fishing gears. The extensive study of the boat-seine gear and its effects to fish stocks, carried out during the fishing period October 2008 - March 2009, in the framework of the Operational Program of Fisheries 2000-2006 of the Hellenic Ministry of Rural Development and Food, constituted an ideal opportunity to study the frequency of occurrence of Lessepsian fishes in the catches of this selective fishing gear operating in the Hellenic coastal zone.

Materials and Methods
For the analysis of the boat-seine catches, the studied hauls were grouped in the following fishing regions : NE. Ionian, SE Ionian, Corithiakos Gulf, NE Aegean, South Evoikos Gulf, Saronikos Gulf, Argolikos Gulf, Cyclades Islands, Lakonikos Gulf and SE Aegean. The frequency of occurrence of each Lessepsian fish species was calculated as the percentage of the hauls in which it has appeared in relation to the total number of hauls examined by fishing region during the whole study period.

Results and Discussion
Seven Lessepsian fish species have been identified from boat-seine catches. At least one Lessepsian species was present in 115 hauls of the 239 hauls examined and at 8 of the fishing regions studied (Table I).

Tab. 1. Frequency of occurrence (%) of Lessepsian fish species in the boat-seine hauls carried out during the fishing period October 2008-March 2009 in the Hellenic coastal zone, by geographic region. The year of species first finding in the Aegean Sea is noted in parenthesis

Fishing Region	*L. sceleratus* (2005)	*F. commersoni* (2001)	*P. pelycus* (1992)	*E. teres* (1999)	*S. luridus* (1964)	*S .rivulatus* (1932)	*S. diaspros* (1943)
NE. Ionian					18.2	4.6	
NE Aegean		2.8					5.6
S. Evoikos Gulf	17.4						60.9
Saronikos Gulf			14.3		14.3	19.1	52.4
Argolikos Gulf	10.7	10.7	10.7		14.3	3.6	39.3
Cyclades Isl.	9.1	18.2	2.3		40.9		50.0
Lakonikos Gulf		11.8	35.3		29.4	11.8	35.3
SE Aegean		100.0	100.0	33.3	100.0	100.0	

The percentage of hauls, where Lessepsian migrants appeared, was considerably higher (>60%) in the southernmost fishing regions of the Aegean Sea, reaching the 100% of hauls realized around Kos island (SE Aegean). This pattern is obviously related with the pathways generally followed by Indo-Pacific species when enter in the Mediterranean Sea through the Suez Canal, first spreading northward along the Asiatic coasts favored by Asia Minor Current and then westwards involved, as adults or more likely as pelagic early juveniles, in the cyclonic and anticyclonic eddies prevailing at south of Rhodos and Crete islands, as well as in the southern Aegean Sea. As it concerns the frequency of occurrence of individual species, it seems to be increased in proportion to the number of years that have passed since the species' first finding in the Hellenic waters (Table I), with the exception of *S. rivulatus* that even if it is the older installed species presents relatively low frequency of appearance , probably due to competition with the sympatric *S. luridus. S. diaspros* was the most often recorded species (at 28% of hauls), followed by *S. luridus* (at 17% of hauls) while the remainder were found in less than 10% of hauls. The present study resulted in substantial northward extension of the previously known expansion for *S. diaspros* and *P. pelycus* [3] that is probably favoured by the rise of sea temperature in the Aegean Sea [4]. The new findings of most Lessepsian species, except *L. sceleratus*, widening their spread in the southern Aegean Sea according to previous records in the data base of the Ellenic Network on Aquatic Invasive Species (ELNAIS), should be rather attributed to the lack of previous systematic study of coastal fisheries catches composition. The exceptional multiple records of *L. sceleratus* during the last 3 years is due mainly to the particular interest that was expressed by the social and scientific institutions because ofits potential risk for human consumption.

References
1 - Peristeraki P., Lazarakis G., Skarvelis C., Georgiadis M. & G. Tserpes., 2006. Additional records on the occurrence of alien fish species in the eastern Mediterranean Sea. *Medit. Mar. Sci.*, 7: 61-66.
2 - Corsini-Foka, M. & Economidis, P.S., 2007. Allochthonous and vagrant ichthyofauna in Hellenic marine and estuarine waters. *Medit. Mar. Sci.*, 8: 67-89.
3 - Corsini-Foka, M. & Kalogirou S., 2008. On the finding of the Indo-Paxific fish *Scomberomorus commerson* in Rhodes (Greece). *Medit. Mar. Sci.*, 9: 167-171
4 - CIESM., 2008. Climate warming and related changes in the Mediterranean marine biota. No 35 in *CIESM Workshop Monographs* (F. Briand, ed.), Monaco, pp 152.

EFFECTS OF CLIMATE-DRIVEN CHANGES ON THE NORTH-CENTRAL ADRIATIC FOOD WEB: INSIGHTS FROM AN END-TO-END APPROACH

S. Libralato [1]*, E. Arneri [2], N. Bahamon [3], M. Coll [3], G. Cossarini [1], E. B. Morello [2], I. Palomera [3], A. Santojanni [2] and C. Solidoro [1]
[1] Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS - slibralato@ogs.trieste.it
[2] Istituto di Scienze Marine (CNR), Ancona, Italy.
[3] Institut de Ciènces del Mar, ICM-CSIC, Barcelona, Spain

Abstract
A biogeochemical model and an Ecopath with Ecosim food web model of the North-Central Adriatic Sea have been integrated for a comprehensive description of ecosystem dynamics. This End-to-End tool has been used to perform scenario analysis for evaluating the effects on high trophic level of potential climatic changes on precipitation and nutrient patterns (changes in timing and volume) in the region.
Keywords: Food Webs, Nutrients, Models, Adriatic Sea

Climatic changes are expected to produce variations that might substantially modify the structure and functioning of marine food webs with important consequences for exploited species. Important factors to be considered include modification of river run-off and water column stratification, which in turn cause modification in nutrient concentration within the euphotic layer with cascading effects on the upper part of the food web. Integration of biogeochemical processes and food web dynamics in an End-to-End approach is a possible way to tackle this issue. In this work, we analyse the potential cascading effects of climate-driven changes on the food web of the North Adriatic Sea ecosystem (Italy, Slovenia and Croatia) by using a hierarchy of linked models. Previous climatic scenario analysis for the North Adriatic region were obtained by comparing highly resolved meteorological outputs of a Regional Climate model (RegCM) for a reference situation (RF, 1961-1990) and two future IPCC scenarios (2071-2100). Results showed local change in the seasonality of precipitation pattern with increase of winter rainy events and a decrease of spring summer precipitation [1],[2]. These changes, observed in both market oriented (A2) and local sustainability policies (B2) scenarios, imply a change in the seasonality of nutrient inputs to the coastal areas whose effects on the food web are studied by using a hierarchy of models. An Ecopath with Ecosim (EwE) model representing the food web of the North-Central Adriatic Sea [3], [4] is forced by a biogeochemical (BGC; [5]) model of the system which, in turn, simulates two future scenarios, one with changes in the seasonality of nutrient inputs (equivalent to A2) and another that also include a general reduction of inputs of nutrient from the rivers due to the implementation of sustainability policies in the land use management (reduction of fertilizers; B2).
The biogeochemical and food web model are integrated through a two steps procedure [6]. In the first step the models are integrated by extending the EwE model for including the main biogeochemical processes thus accounting for all possible interactions among high and low trophic levels. In the second step the nutrient inputs are adjusted in the extended model in order to adjust to the BGC results in terms of nutrient dynamics. The adjustments are necessary for accounting differences in parameterization of the two models, including differences in the time and space scheme used [7]. The effects of climate-driven changes on higher trophic levels are analyzed by comparing the long term evolution of biomass for different trophic groups simulated under the different scenarios, with particular attention to species target of fishing activities (e.g. small pelagic species and demersal predators).

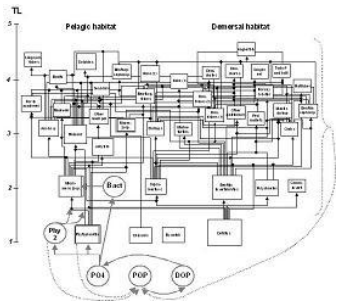


Fig. 1. Schematic representation of the End-to-End model for the North Adriatic Sea used in the climatic scenario analysis. The original food web model comprehend 40 functional groups (black boxes and arrows), that is extended to describe the biogeochemical processes (grey circles and arrows)

This work was developed within the context of the SESAME project—EC Contract No. GOCE-036949, funded by the Sixth Framework Programme.

References
1 - Salon S., Cossarini G., Libralato S., Gao X., Solidoro C., Giorgi F., 2008. Downscaling experiment for the lagoon of Venice. Part I: validation of the present-day precipitation climatology. *Clim. Res.*, 38: 31-41.
2 - Cossarini G., Libralato S., Salon S., Gao X., Giorgi F., Solidoro C., 2008. Downscaling experiment for the lagoon of Venice. Part II: potential effects of changes in precipitation on biogeochemical properties. *Clim. Res.*, 38: 43-59.
3 - Coll M., Santojanni A., Arneri E., Palomera I., Tudela S., 2007. An ecosystem model of the northern and central Adriatic Sea: analysis of ecosystem structure and fishing impacts. *J. Mar. Sys., 67:119*–154.
4 - Coll M., Santojanni A., Palomera I., Arneri E., 2009. Food-web changes in the Adriatic Sea over the last three decades. *Mar. Ecol. Progr. Ser.*, 381: 17-37.
5 - Cossarini G., Solidoro C., 2008. Global sensitivity analysis of a trophodynamic model of the Gulf of Trieste. *Ecol. Mod.*, 212: 16-27.
6 - Libralato, S., Solidoro, C., 2009. Bridging biogeochemical and food web models for an End-to-End representation of marine ecosystem dynamics: The Venice lagoon case study. *Ecol. Mod.*, 220: 2960–2971.
7 - Solidoro C., Cossarini G., Libralato S., Salon S., 2009. Remarks on the redefinition of system boundaries and model parameterization for downscaling experiments. Prog. Ocean., accepted.

TEMPORAL EVOLUTION OF DEMERSAL SPECIES ABUNDANCE IN THE NORTHERN TYRRHENIAN SEA

A. Ligas [1], P. Belcari [2], D. Bertolini [1], S. De Ranieri [2], D. Micheli [2], B. Reale [1], M. Sartini [3], P. Sartor [1]* and M. Sbrana [1]
[1] Centro Interuniversitario di Biologia Marina ed Ecologia Applicata "G. Bacci" - psartor@cibm.it
[2] Dip. di Scienze dell'Uomo e dell'Ambiente, University of Pisa, Via Derna 1, 56126 Pisa, Italy
[3] Aplysia Soc. Coop.r.l., Via Menichetti 35, 57121 Livorno, Italy

Abstract
The 1991-2006 time series of trawl survey data of five demersal species were analysed by means of Min/Max Auto-correlation Factor Analysis (MAFA). The influence of some environmental variables and some fishing effort indices was evaluated as well. The results highlighted the presence of two most important trends in the multiple time series data set.
Keywords: Demersal, Time Series, Trawl Surveys, Tyrrhenian Se

Introduction
A central challenge in fisheries ecology is to understand why species abundance changes over time [1]. Fishing exploitation is considered one of the main factors determining demersal resources dynamics, although both abiotic and biotic variables influence population abundance. In this context, the time series of experimental trawl survey data are useful to investigate trends and variations of the stocks, their spatial distribution, their relative abundance, etc. The present study aimed to investigate the temporal variations of the populations of five demersal species in the northern Tyrrhenian Sea through the analysis of the time series obtained from trawl surveys. Moreover, the study is focused to investigate the effect of some potential explanatory variables, such as fishing effort indices and environmental factors. The species considered for the study are the horned octopus, *Eledone cirrhosa*, the European hake, *Merluccius merluccius*, the red mullet, *Mullus barbatus*, the Norway lobster, *Nephrops norvegicus* and the deep-water rose shrimp, *Parapenaeus longirostris*; these species represent more than 50% of the biomass landed by the trawlers exploiting the fishing grounds in the northern Tyrrhenian Sea.

Materials and Methods
The study was performed in the northern Tyrrhenian Sea, where important traditional trawl fisheries are present. During the investigated period (1991-2006), two experimental trawl surveys per year have been carried out in the framework of national and international projects on the assessment of demersal resources. The time series of mean biomass (kg/km^2) were calculated. To investigate the effect of environmental factors, time series of mean monthly values of sea surface temperature (SST, °C), wind speed (W, m/s), and North Atlantic Oscillation index (NAO) were used (http://podaac.jpl.nasa.gov/index.html). Indices of fishing activity and capacity were computed from the Porto Santo Stefano trawl fleet, the main fishing harbour in the area: the total number of days at sea performed by the fleet per month, and the mean gross tonnage (GRT) of the fleet per month. The data were analysed by means of the MAFA (Min/Max Autocorrelation Factor Analysis), a statistical method to extract common trends from multiple time series, and to analyse relatively short data sets [5]. Cross-correlations between the variables and the trends were computed to evaluate the significance of the relationship between the variables and the estimated trends [2].

Results and discussion
The results obtained by means of Min/Max Auto-correlation Factor Analysis (MAFA) highlighted the presence of two main trends (Fig. 1) in the multiple time series data set.

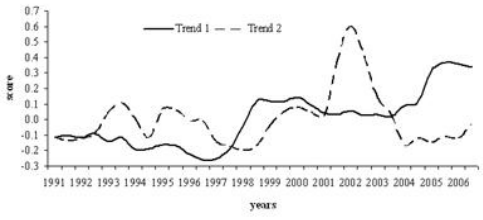


Fig. 1. Common trends extrapolated from the multivariate time series data set by means of MAFA

The first trend described an increasing pattern, while the second showed a general rather constant behaviour, even though characterized by a sharp peak in 2002. As highlighted by the cross-correlations (Tab. 1), the first trend was significantly related to the time series of the deep-water rose shrimp, *Parapenaeus longirostris*. The Norway lobster, *Nephrops norvegicus*, time series was negatively related to this trend, indicating that this species followed an opposite pattern. The European hake, the red mullet and the horned octopus time series were significantly related to the second MAFA trend.

Tab. 1. Cross-correlations between variables and MAFA trends. Response variables: MM = *Merluccius merluccius*, MB = *Mullus barbatus*, EC = *Eledone cirrhosa*, NN = *Nephrops norvegicus*, PL = *Parapenaeus longirostris*. Explanatory variables: Wind = wind speed (m/s), NAO = NAO index, SST = sea surface temperature (°C), Days at sea = number of days at sea per month, GRT = mean gross tonnage. Significance level for correlations ± 0.35. Significant values are highlighted in bold

		Trend 1	Trend 2
Response variables	MM	0.18	**0.43**
	MB	0.11	**0.75**
	EC	-0.02	**0.82**
	NN	**-0.42**	-0.30
	PL	**0.98**	-0.14
Explanatory variables	Wind	-0.31	-0.23
	NAO	0.16	-0.03
	SST	-0.06	0.07
	Days at sea	**-0.41**	0.30
	GRT	-0.16	**0.70**

As concerns the explanatory variables, only the fishing effort indices showed significant correlations with the MAFA trends. The time series of the number of fishing days per month was negatively correlated to the first trend, while the mean GRT time series was related to the second trend. Therefore, the available evidence suggests that fishing effort resulted more important than environmental factors in influencing the trends. The number of fishing days per month time series was negatively related to the first trend. In the investigated period the trawl fleet of Porto Santo Stefano decreased of about the 50% in terms of number of vessels, producing an almost proportional decrease of fishing effort [3]. The reduction of fishing effort was mainly due to the Common fishery policy for the Mediterranean, which promoted the effort reduction through incentives to demolition. The mean size of the trawl vessels of Porto Santo Stefano has increased until 2000s; however, in the last years, it has followed a decreasing pattern, in response to the global crisis which invested fisheries, and to the sharp increase of the diesel oil costs [4].

References
1 - Ciannelli L., Fauchald P., Chan K. S., Agostini V.N., Dingsør G.E., 2008. Spatial fisheries ecology: recent progress and future prospects. *Journal of Marine Systems*, 71: 223-236.
2 - Erzini K., Inejih C.A.O., Stobberup K.A., 2005. An application of two techniques for the analysis of short, multivariate non-stationary time-series of Mauritanian trawl survey data. *ICES J. Mar. Sci.*, 62 (3): 353-359.
3 - Sbrana M., Viva C., Belcari P., 2006. Observation on the fishery of the deep water rose shrimp *Parapenaeus longirostris* (Lucas, 1846) (Crustacea: Decapoda) in the northern Tyrrhenian Sea (western Mediterranean). *Hydrobiologia*, 557: 135-144.
4 - Valdemarsen J.W., 2001. Technological trends in capture fisheries. *Ocean Coast. Manage.*, 44: 635-651.
5 - Zuur A.F. and Pierce G.J., 2004. Common trends in Northeast Atlantic squid time series. *Journal of Sea Research*, 52: 57-72.

A MAP OF THE MEDITERRANEANSEA FOR FISHERY PURPOSES USING GOOGLE EARTH

Jordi Lleonart [1]*, Juan Luis Suarez De Vivero [2], Susana Requena [3] and Silvia De Juan [1]
[1] Institut de Ciencies del Mar. CSIC - lleonart@icm.csic.es
[2] Department of Human Geography. University of Sevilla. Spain
[3] RAC/SPA Consultant

Abstract
A chart of the Mediterranean, using Google Earth, is being developed with the objective to help fisheries scientists easily place the different georeferenced features related to fisheries (undersea features, MPAs, jurisdictions, etc.). The map is an open tool and can be improved by users. This tool has been developed in the framework of the activities of UNEP RAC/SPA
Keywords: Fisheries, Mapping

The UNEP Regional Activity Centre for Specially Protected Areas (RAC/SPA) in compliance with the Mediterranean SPA/BD Protocol, undertook an initiative to promote the establishment of a Specially Protected Areas of Mediterranean Importance (SPAMIs) network, including Mediterranean high seas. In that context, along with the project "Fisheries management/conservation and step-relief areas in the Mediterranean open seas, including deep seas" [1,2], the UNEP RAC/SPA has promoted the development of a geographic tool related to fisheries to help scientists and other potential users working with georeferenced information coming from different sources. Google Earth has been chosen as a user friendly and free software in order to develop such a tool as it will facilitate access to the general public. The map presented has several folders containing the following information:

- Bathymetry. Isobaths of 50, 100, 200, 1000, 2000, 3000, 4000 and 5000 m depth are included. The information has been obtained from GEBCO [3].
- Jurisdictions. It contains information about: internal waters, historical bays, territorial waters, archaeological contiguous area, fishing protection zones, ecological protection zones, exclusive economic zones, high seas, and other particular jurisdictions [4].
- MPAs. Including: UNEP RAC/SPA SPAMIS, GFCM FRAs (Fishing Restricted Areas), MPAs for cetacean conservation, proposals for tuna sanctuaries and any other MPA appeared in MEDPAN and MPAGLOBAL websites. About 280 MPAs are included. In most cases associated to the website that contains its description
- Undersea features. Includes all geomorphological features with a published name. About 35 types of features (the most common, seamounts, canyons, ridges, plains, etc.). The map contains about 450 georeferenced geographical localizations.
- Boundaries, subareas and grids. Contains the different subareas defined by FAO for statistical purposes, and GFCM. It also contains the 10 and 50 km grids promoted by the European Union for environmental purposes.
- Sea surface temperature (SST) and surface primary productivity in terms of chlorophyll-a concentration. Charts of summer and winter averaged temperature and productivity from 2003 to 2008, as well as the main isolines [5]. When possible the georeferenced element is associated to additional information with a link. This map aspires to be an operational tool for marine scientists working in the Mediterranean. It is posted in the public domain and feedback from users, for comments, corrections and additions is expected.

References
1 - De Juan, S. and Lleonart, J., 2009. Fisheries management/conservation and step-relief areas in the Mediterranean open seas, including deep seas. Contract N° 34/2009_RAC/SPA. 100p.
2 - Requena Moreno, Susana., 2009. Georeferenced compilation of information for the identification of possible SPAMIs in the Mediterranean areas beyond national jurisdiction. Contract N° 33/2009 Regional Activity Centre for Specially Protected Areas (RAC/SPA), Tunis.
3 - IOC, IHO and BODC. 2003. Centenary Edition of the GEBCO Digital Atlas, published on CD-ROM on behalf of the Intergovernmental Oceanographic Commission and the International Hydrographic Organization as part of the General Bathymetric Chart of the Oceans, British Oceanographic Data Centre, Liverpool, U.K.
4 - United Nations., 1982. Oceans and Law of the Sea. Division for Oceans Affairs and Law of the Sea (updated data in http://www.un.org/Depts/los/index.htm).
5 - Acker, J. G. and G. Leptoukh., 2007. Online Analysis Enhances Use of NASA Earth Science Data, Eos, Trans. AGU, Vol. 88, No. 2 (9 January 2007), pages 14 and 17.

FISH ASSEMBLAGES AROUND FISH AGGREGATION DEVICES IN AEGEAN SEA COAST OF TURKEY

Altan Lök [1]* and Aytaç Özgül [1]
[1] Ege University, Fisheries Faculty - altanlok@yahoo.com

Abstract
Fish assemblage associated with fish aggregating devices (FADs) in Aegean Sea was carried out between June 2008 and June 2009. Two FADs and two control areas were established to check the aggregation efficiency of the FADs. Small-scale fisheries techniques and underwater visual census have been conducted around of FADs and control sites monthly. A total of 17 families and 24 species of fishes were observed beneath FADs. Pelagic fishes, largely *Trachurus spp.*, *Seriola dumerili*, *Coryphaena hippurus* and*Xiphias gladius*, dominated the fauna. This study is also show that FAD is provide good opportunity to understand pelagic ecosystem.
Keywords: Aegean Sea, Artificial Reefs, Biodiversity, Fisheries, Pelagic

Introduction
Associations of fishes with flotsam have been widely reported in the literature [1, 2] from subtropical and temperate waters. However, few data are available on the Mediterranean [3, 4]. Despite of the fact that FADs have been used in the other countries for many years, using of FADs for fishing or same aims not reported in coats of Turkey. Any records couldn't be found on use of FADs in pelagic fisheries in coast of the Aegean Sea and Eastern Mediterranean. Therefore, this study has been became the first for Eastern Mediterranean area. This paper focused on the description of composition, abundance and seasonality of fishes associated with FADs in Eastern Mediterranean (Aegean Sea).

Material and Methods
This study was conduct off Gümüldür village which located 40 km south of Izmir. Two steel FADs units were moored in water at 50m and 100m depths respectively. Two zones without FAD, separated one nautical mile from each FADs unit and at the same depth, were taken controls to test for the aggregation behavior of the species. The study was carried out from July 2008 to June 2009. Seasonal variability was studied by sampling each FADs and control cities with a monthly. Samples were collected with small scale fisheries techniques (angling, trolling, gillnet and pelagic loglines) around of FADs and control sites. Underwater visual observations were also conducted to obtain qualitative information on the spatial distribution of fishes.

Results
A total of 17 families and 24 species of fishes were observed beneath FADs. Pelagic fishes, largely *Trachurus spp., Seriola dumerili, Coryphaena hippurus* and*Xiphias gladius*, dominated the fauna. The observed specimens were mainly juveniles, with the exception of a few adults of *Balistes capriscus, Centrolopus niger, Lepidopus caudatus* and *Corypheana hippurus*. The recruitment of juvenile middle-sized pelagic fishes to FADs was rapid, with shoals being presented only a few days after FADs deployment.

References
1 - Gooding, R. M., Magnuson, J.J., 1967. Ecological significance of a drifting object to pelagic fishes. *Pac. Sci*. (21), 486-497.
2 - Durace, B. E., Kingsford, M. J., 1995 An experimental investigation of the fishes associated with drifting objects in coastal waters of temperate Australia. *Bulletin of Marine Sciences* 57 (2), 378-392
3 - Relini, G., Relini, M., Montanari, M., 2000. An offshore buoy as a small artificial island and a fish aggragating device (FAD) in the Mediterranean. *Hydrobiologia* 440: 65-80
4 - Andaloro, F., Campo, D., Castriota, L., Sinopoli, M., 2007. Annual trend of fish assemblagee associated with FADs in the southern Tyrrhenian Sea. *Journal of Applied Ichthyology* 23: 258-263

PRELIMINAR STUDY ON FISHING YIELDS IN THE VICINITY OF TWO NO-TAKES ZONES WITHIN THE MARINE RESERVE OF CABO DE GATA-NIJAR (ALMERIA-SPAIN)

Matias Lozano [1], Jorge Baro [1]*, Teresa Garcia [1] and Javier Rey [1]
[1] Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Apdo. 285, 29640 Fuengirola, Málaga, Spain - jorgebaro@ma.ieo.es

Abstract
Marine protected areas (MPAs) are an instrument for improving both fisheries management and marine environmental protection. In order to analyse possible differences in fishing yields we studied the vicinity of two no-take zones (close and further to home harbour) within the MPA located in Cabo de Gata (Almeria, Spain). Species abundance showed a spatial distribution along the coast with two clear separate groups. We suggest that those differences might be due to the effect of fishing pressure.
Keywords: Fisheries, Coastal Management

Introduction
The Cabo de Gata-Níjar Marine Reserve (CGMR) is situated in the Western Mediterranean (Fig. 1), in the southeast of the Iberian Peninsula. This coastal MPA covers 4,600 ha and represent typical Mediterranean habitats, such as rocky reefs, sandy bottoms and *Posidonia oceanica* seabeds. Local fishing activities are restricted to artisanal fisheries, which are often coastal with boats smaller than 10 m. Within the protected areas and outside the no-take zones (fishing is prohibited), artisanal fishing is undertaken using traditional fishing gears (gill net and trammel net) on diverse target species depending on their abundance and price. Many factors have a significant influence on effort allocation by the fishing fleets, such as distance to the port, distance to the no-take zone and water depth [1]. In general, most of the fishing effort is concentrated near the no-take zones especially those closer to home harbour. In Cabo de Gata, the prevailing winds, both east and west, produce losses of between 30-40% of the fishing days during the year, therefore can be considered a factor that could influence the spatial allocation of the fishing effort.

Materials and Methods
In this study we aim to investigate catch abundance within the vicinity of two no-take zones in the CGMR with different accessibility (one close to home harbour (2 nm) and the other further away (8nm)). Experimental fishing surveys in the CGMR were conducted during May 2009 with two artisanal boats operating in the area, with the same gear type used in commercial fishing (Common cuttlefish trammelnets).

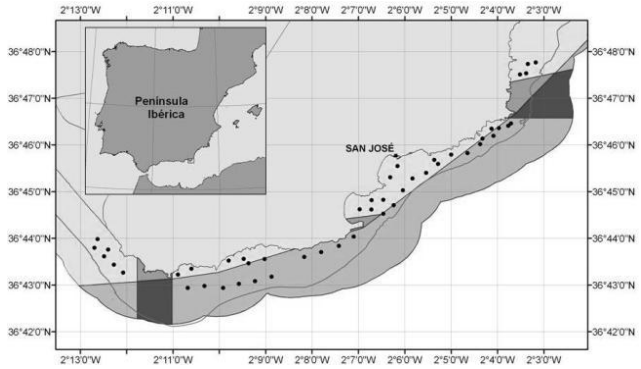


Fig. 1. Location of Cabo de Gata-Nijar Marine Reserve (CGMR) on the southest of the Iberian Peninsula. Dots illustrate the experimental fishing sets

Results and Discussion
A total of 48 fishing sets were sampled and sixty species were collected during the study (45 of fish, 6 of mollusc, 5 of crustacean and 5 of equinoderms). To establish the contribution of each species to the mean abundance Bray-Curtis dissimilarity within a group and between groups of samples, similarity percentage analysis (SIMPER) routine was used (PRIMER 6). The MDS analysis revealed differences between both (near and further away) fishing sites. We suggest that those differences might found be due to the effect of fishing on the dominant species *Sepia officinalis*.

References
1 - Stelzenmoller, V., Maynou, F., Bernard, G., Camiller, M., Criquet, G., Esparza, O. and Perez-Ruzafa., 2008. A. Spatial assessment of fishing effort around European marine reserves: Implications for successful fisheries management. *Marine Pollution Bulletin*, 56: 2018-2026.

PREMIERE DESCRIPTION DE MALFORMATION DU PIED CHEZ LE MOLLUSQUE BIVALVE *RUDITAPES DECUSSATUS* (LINNE 1758) PRELEVE SUR LES COTES TUNISIENNES

J. Maatoug [1], T. El Ayari [1], F. J. Kefi [1], L. Gargouri Ben Abdallah [2] and N. Trigui El Menif [1]*
[1] Laboratoire de Biosurveillance de l'Environnement, Faculté des Sciences de Bizerte, 7021, Tunisie - elmunif2004@yahoo.fr
[2] Laboratoire de Parasitologie, Faculté des Sciences de Tunis, 1060 Tunisie

Abstract
L'examen de la partie molle de la palourde *Ruditapes decussatus*, prélevée pendant les saisons, estivale et automnale, de l'année 2009 nous a permis de révéler la présence d'une malformation très marquée touchant la morphologie du pied du bivalve. Le suivi spatial de cette perturbation, dans trois stations du littoral tunisien, a montré que le taux, la position et le degré de développement de cette anomalie varient d'une station à l'autre. Nous avons également constaté la présence d'un byssus chez 0,47% de spécimens collecté dans une des trois stations.
Keywords: Bivalves, Pollution, Coastal Waters, Mollusca

Introduction
Ruditapes decussatus est un bivalve d'intérêt économique important. Il se rencontre en Atlantique et en Méditerranée [1]. Cette espèce endogée s'enfouit dans le sédiment grâce à son pied [2]. Lors d'une étude bioécologique, nous avons mis en évidence une malformation très marquée du pied. Cette étude décrit les malformations observées et détermine l'intensité de cette anomalie ainsi que les variations spatiales.

Matériel et Méthodes
Un effectif total de 1 325 spécimens de 19 à 39 mm a été collecté par pêche à pied durant l'été et l'automne 2009 dans trois stations : Radés (nord de la Tunisie), Gargour et le port de pêche de Sfax (Sud Tunisien) (fig1). Au laboratoire, les animaux, de chaque station, ont été comptés puis examinés macroscopiquement et sous loupe binoculaire. Les spécimens prélevés dans chacune des trois stations ont été comptés en vue d'étudier les variations spatiales. Les différents types et degrés de développement de la malformation observée ont été décrits.

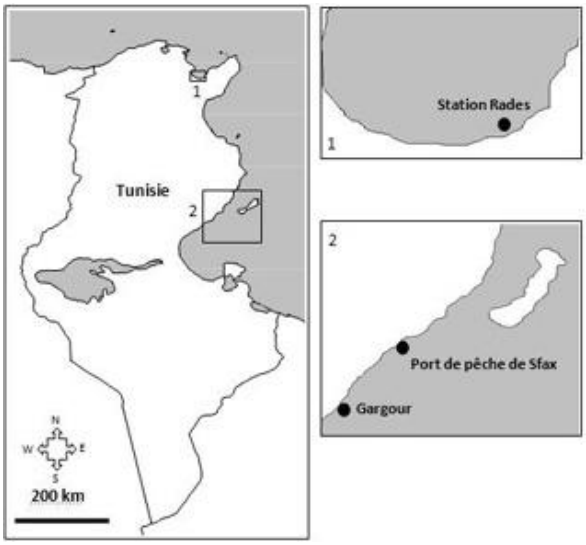


Fig. 1. Carte de la Tunisie montrant les sites de prélèvement de la Palourde *Ruditapes decussatus*.

Résultats et discussion
Les observations macroscopiques et microscopiques du pied de Ruditapes decussatus ont révélé la présence d'une malformation qui se manifeste par la différenciation d'une gouttière rectiligne dans le sens antéropostérieur. Cette gouttière, plus ou moins profonde, peut évoluer en longueur et en profondeur donnant deux pieds séparés uniquement du côté ventral. Certains spécimens montrent, en plus, une séparation dorsale. L'animal se trouve donc avec deux pieds complètement indépendants. Certaines palourdes montrent une gouttière et une bifurcation du bout antérieur du pied. Dans ce dernier cas, le stade ultime donne naissance à deux pieds séparés partiellement ou totalement. Le taux de spécimens touchés par cette perturbation (fig.2) est de 100% dans la station du port de pêche de Sfax (effectif examiné = 427). A Gargour, le taux est de 99,66% (spécimens examinés = 598) contre 46% à Radés (effectif examiné = 300). Nous avons par ailleurs constaté, chez les spécimens du port de Sfax, la présence d'un byssus assez moelleux plus ou moins long (environ 8 mm de long et 1 mm de large) se différenciant du côté postérieur du pied. Le taux de spécimen à byssus est très faible (0.47%). Cette malformation est semblable à celle décrite par Atkins [3] chez la moule Mytilus edulis. Cette anomalie se manifeste par le développement, chez le bivalve, d'un pied surnuméraire à partir du pied principal. Selon le même auteur, le pied de la moule peut également subir soit une atrophie soit une lésion. L'origine de cette anomalie est inconnue [3]. En ce qui concerne notre étude, plusieurs causes peuvent intervenir dans l'apparition de telles anomalies chez Ruditapes decussatus. En effet, les conditions environnementales, la pollution, l'hydrodynamisme, le parasitisme sont des facteurs qui peuvent avoir un impact direct ou indirect sur la morphologie du pied de l'animal. D'après Bartoli [4], le parasitisme intensif chez Venerupis aurea peut modifier le comportement du bivalve en renversant la position normale du bivalve dans le sédiment. Des études, génétique et parasitologique, sont en cours de réalisation en vue de rechercher les causes de cette malformation.

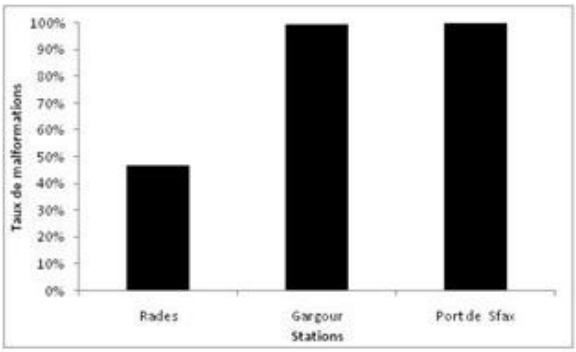


Fig. 2. Variation du taux de la malformation du pied du bivalve en fonction des stations d'étude.

References
1 - POUTIERS J.M., 1987. *Fiches FAO* d'identification des espèces pour les besoins de la pêche –Méditerranée et Mer Noire. Zone de pêche 37. Révision 1.1 : 440-446.
2 - Grassé P.P., 1968. Traité de zoologie : *Anatomie, Systématique, Biologie des Mollusques Gastéropodes et Scaphopodes*. Tome V, Fascicule III. 1024p.
3 - ATKINS D., 1931. Note on some abnormalities of the Labial Palps and Foot of *Mytilus edulis*. Part. I. Structural with a note on the method of division of the mantle cavity in normal individuals. *J.Mar.Biol.Assoc. U. K.* 16 : 545-550.
4 - Bartoli P., 1976. Modification de la coissance et du comportement de *Venerupis aurea* parasite par *Gymnophallus fossarum* p Bartoli, 1965 (Trematoda, Digena). *Haliotis., 7 : 23-28.*

PERIODISM OF *CYSTOSEIRA SPINOSA* SAUV. (FUCALES) FROND SIZE ON THE MONTENEGRIN COAST

Vesna Macic [1]*

[1] Institute of marine biology - vmacic@ibmk.org

Abstract

Cystoseira spinosa periodism and size structure were studied on three locations of the Montenegrin coast (Adriatic Sea). Samples were taken from Orahovac, Perast and cape Kocište in different seasons between autumn 2005 and spring 2007, at 5m depth. The analysis were made on obtained data for total wet biomass, *C. spinosa* wet biomass, maximum length, length of the main axes and length of ten randomly selected primary branches. For better understanding of *C. spinosa* periodism and monitoring further analysis of deeper populations are needed.

Keywords: Adriatic Sea, Algae, Endemism, Phytobenthos

Introduction

According to published data *Cystoseira* species are very sensitive to antropogenic impacts and there are tendences of their regresions from urban areas. In recent years many scientific efforts has been dedicated to research of the genus Cystoseira as bioindicator species for evaluating environmental state and some antropogenic impacts. In these activities historical data are of great importance, but unfortunately they are very scarse for the Montenegrin coast ([1], [2], [3]). Therefore the aim of this work was to contribute to the better knowledge of endangered, endemic Mediterranean brown algae, *Cystoseira spinosa* Sauv., its periodism and size structure and to provide better base information for further monitoring.

Materials and Methods

The field research was done by seasonal SCUBA diving, on 3 locations: Orahovac, Perast and cape Kocište (Fig. 1), between autumn 2005 and spring 2007 (excluding winter 2006). Sampling was done in 3 replicates scraping off all organisms within quadrates 25cm x 25cm at 5m depth. Following parameters were measured: total wet biomass, *Cystoseira* wet biomass, maximum length, length of the main axes and length of ten randomly selected primary branches. Measured *Cystoseira spinosa* specimens are conserved in 4% formaldehyde solution.

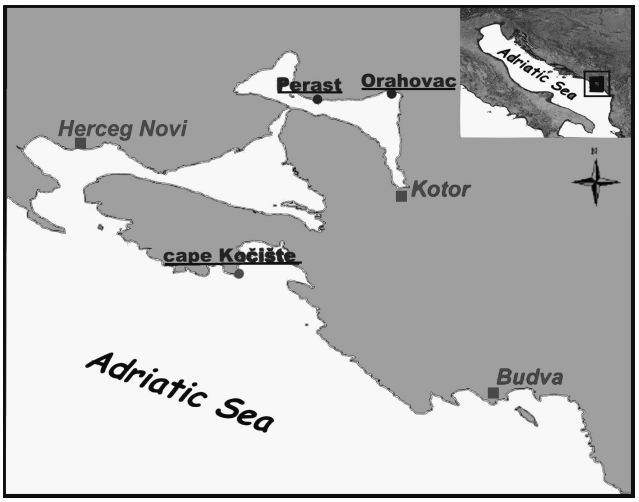


Fig. 1. Locations of the study

Results and Discussion

Seasonal variation of total biomass, with maximum in spring were clearly evident, contrary to biomass of *Cystoseira*. Differences in wet weights of *C. spinosa* between selected locations were significant (F-test and Duncan test, $p<0,05$) and the highest between Perast (66.7g/m^2) and Kocište (759.9g/m^2). The biggest variability of maximum length, length of main axes and primary branches were noted in the spring (Fig. 2).

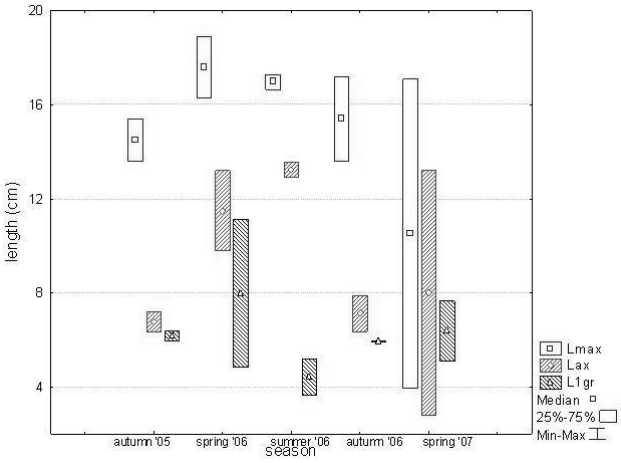


Fig. 2. Values of length for different seasons (Lmax-maximum length; Lax-length of axes and L1gr-length of primary branches)

Some autors ([4], [5]) acknowledge weak seasonal variation of length for main axes and its independes of the phenological state of plants. In this study the lengths of main axes were different significantly (F-test and Duncan test, $p<0,05$) between locations. Furthermore, as for wet biomass, also for the length of main axes, location Orahovac was with highest variability (6.35-13.2cm) and location Perast with highest values (13.55cm). Conceptacles were apical and present only in the spring.

With scope to improve knowledge of phytobenthos of the Montenegrin coast two new locations for the distribution of *Cystoseira spinosa* are presented (Orahovac and cape Kocište). For this part of the south-east Adriatic Sea presented data of periodism and size structure for this algae are the first one and more or less are similar to data from other parts of Mediterranean Sea. However, because of great polymorphism of *Cystoseira spinosa* further analysis of deeper populations are needed, as well as further monitoring of differences found in this study.

References

1 - Ercegovic, A., 1952. Jadranske Cistozire. Njihova morfologija ekologija I razvitak. *Fauna et flora Adriatica, IOR*, Split, 2: 1-212.

2 - Antolic, B., Span, A., 1992. The inventory of benthic flora of the Baz Boka Kotorska (southern Adriatic). *Acta Adriatica*, 33 (1/2):75-84.

3 - Span, A., Antolic, B., 1983. Prilog poznavanju fitobentosa Crnogorskog primorja (juzni Jadran). *Studia Marina*, 13-14: 87-110.

4 - Ballesteros, E., Sala, E., Garrabou, J. and Zabala, M., 1998. Community structure and frond size distribution of a deep water stand of *Cystoseira spinosa* (Phaeophyta) in the Northwestern Mediterranean. *Eur. J. Phycol*., 33: 121-128.

5 - Serio, D., 1995. Fenologia morfologica e riproduttiva di *Cystoseira spinosa* Sauvageau v. *compressa* (Ercegovic) Cormaci et al., (Fucales, Fucophyceae). Boll. Acc. Gioenia Sci. Nat., Vol. 28., n. 349: 5-22.

USE OF LAPAROSCOPY FOR THE EVALUATION OF THE REPRODUCTIVE APPARATUS OF EEL (ANGUILLA ANGUILLA)

F. Macri [1], G. Lanteri [1], P. Giorgianni [1], C. De Stefano [1], F. Bucci [2] and G. Aiudi [2]*
[1] Dipartimento di Produzione Animale Università degli Studi Messina - g.aiudi@veterinaria.uniba.it
[2] Dipart Sanità Pubblica Veterinaria Università degli Studi Messina

Abstract
In this paper we evaluate the application of laparoscopy for the assessment of the reproductive status of the European eel, *Anguilla anguilla*, with the final goal of recognizing the mature stage of the gonads. Laparoscopy was carried out on 20 anesthetized eels, using a 1.9 mm rigid cystoscope. Gonads were visualized and histological samples were collected with a forceps and showed presence of gametes at different maturity stages. The application of laparoscopy can be powerful to evaluate sex and to establish the reproductive status of the gonads of eel.
Keywords: Fishes, Reproduction

Introduction
Laparoscopy is a useful diagnostic and therapeutic tool in human and, recently, in veterinary medicine. There are only few reports on laparoscopy application in teleosts [1]. This study is aimed at evaluating in eel the use of laparoscopy to analyze the reproductive tract and to detect the maturation stage of the gonads.

Material and Methods
Laparoscopy was performed on 20 eels (Anguilla anguilla) 60 cm medium length. The study was performed with a rigid cystoscope, a pump for air insufflation and a video device; a forceps was used to collect the bioptic samples. The fish were anesthetized in a tank containing MS 222 0.3 mg/L, and then placed on a grid out of the water; the anesthesia has been maintained conveying water containing MS 222 0.4 mg/L through a small aspiration pump in the oral cavity of the fish, using an i.v. flow regulator; the water has never been recycled. Laparoscopy was carried out placing fish on dorsal decubitus. A pneumocoelom was performed in order to separate the abdominal wall from the viscera. A small paramedian surgical incision, close to the anal pore, allowed the introduction of the Veress needle, linked to the insufflator through an i.v. flow regulator. The laparoscopic surgery door was made with the same procedure about 1 cm cranially from the first incision. After the examination, the coelom was emptied of air and treated with Enrofloxacin 14 mg/Kg; the laparoscopic entry sites were sutured with Vicryl (from 5-0 to 2-0). The fish were then placed again in the tank and the recovery was reached few minutes later. The bioptic samples were processed for paraffin-embedding. Slices were stained with Ematoxylin-Eosin. The follow-up showed a quick recovery and excluded the presence of post-surgery lesions as well as functional alterations within 3 months.

Results
During the laparoscopy the gonads were visualized as paired organs attached to the swimbladder. The histological examination showed presence of gametes at different maturity stages in both sexes. Ovaries were characterized by oocytes at different stage of maturation. Previtellogenic ones were characterized by a reduced size, an evident nucleus and a dense and deeply stained cytoplasm. Vitellogenic oocytes included ova with nucleus still evident and one or more layer of vacuoles filled with lipid yolk, and large ova with vacuoles and stained cytoplasmic material (protein yolk) covering the nucleus. The testes were characterized by Sertoli cells and primordial germ cells.

Discussion
One of the major challenges in fish reproduction is the precise assessment of the gonadal maturity stage before hormone conditioning, necessary for stimulating gamete release in several farmed species [2]. Generally fish not showing sexual dimorphism are sexed through direct observation of gonads, sacrificing the fish, therefore this technique is not reliable for endangered species or expensive fish such as broodstock; radio-immuno assays for determine sex hormone concentration, even if not lethal, is difficult and expensive, and not very sensitive in case of low levels of sex hormones e.g. young fish or onset of reproductive activity [3, 4]. The laparoscopy showed a big potential allowing direct visualization of the gonads and a quick examination. The main problems of this procedure are the cost of the devices, the high expertise and training of the staff and the small size of many teleost fish with consequent potential injuries to coelom organs/cavity.

References
1 - Macrì, F., Aiudi, G., De Majo, M., Quartuccio, M., Cimino, S., Marino, F., 2008. Laparoscopia nei Teleostei: Risultati Preliminari. *Veterinaria* 6, 33-40.
2 - Ortenburger, A.I., Jansen, M.E., Whyte, S.K., 1996. Nonsurgical videolaparoscopy for determination of reproductive status of the Arctic charr. *Canadian Veterinary Journal* 37, 96-100.
3 - Martin, R.W., Sower, S.A., Phillips, D.J., MCauley, C., 1983. Ultrasonic imaging, a potential tool for sex determination of live fish. *North American Journal of Fisheries Management* 3, 258-264.
4 - Crim, L.W., Glebe, B.D., 1990. Reproduction. Schreck CB, Moyle PB, eds. Methods for Fish Biology. Bethesda: American Fisheries Society, 529-553.

GASTROSCOPIC, LAPAROSCOPIC AND PATHOLOGICAL FINDINGS IN EXPERIMENTAL ANISAKIASIS IN SEA BASS

F. Macrì [1], M. Manganaro [1], G. Caristina [1], B. Busalacchi [2]* and F. Marino [1]
[1] C.I.S.S. Dipartimento Sanità Pubblica Veterinaria, Università di Messina
[2] Istituto per l'Ambiente Marino Costiero (IAMC) - CNR Messina - barbara.busalacchi@iamc.cnr.it

Abstract
In this paper we evaluate and discuss the tissue damage due to Anisakis larvae in experimentally infected sea bass (*Dicentrarchus labrax*). This is the first endoscopic and laparoscopic study, that has revealed in two fishes hemorrhages and/or nodules on the serosal surface of the intestine. The evidence of tissue change is an unusual occurrence in Anisakis infected teleost fish.
Keywords: Parasitism, Teleostei, Pathology

Introduction
Anisakid nematodes are probably the most known fish parasites, also because of their zoonotic potential. The life cycle of these cosmopolite parasites involve marine mammals or fish-eating birds as definitive host and various aquatic invertebrate species, teleosteans and cephalopod molluscans as intermediate and/or paratenic hosts. The tissue damage evoked by these nematode larvae on their teleost host is generally very low. They can be found on the serosa of coelomic organs without any apparent tissue reaction. However its importance as fish-borne zoonosis, few data demonstrate the possibility of experimental induction of the disease from a fish to another using L3 larvae without intermediate host [2,5]. Moreover imaging techniques have been rarely used in teleost fish. This paper is aimed at show the laparoscopic findings obtained during a challenge with *Anisakis* larvae in one of the most common fish species in Mediterranean aquaculture, as the sea bass, with known susceptibility [1].

Material and Methods
Five fish belonging to the species *Dicentrarchus labrax* were reared in an aerated tank, 650 l, for 60 days, temperature 25°C, salinity 35‰. Fish were anaesthetized using MS-222. The challenge was performed by endoscopy, using 10 alive *Anisakis* larvae inserted into the stomach of each fish. Larvae were obtained by the simultaneous necropsy of three teleost fish belonging to the species *Lepidopus caudatus*. Another challenge with the same protocol was performed 15 days later. At this time, endoscopic exam was carried out. After 60 days, in which fish were daily monitored, an explorative laparoscopy, using a rigid cystoscope, was performed. Fish were carefully examined for *Anisakis* larvae, after induction of pneumocoelom in a way to show all parietal and visceral coelomic surfaces.

Results
Endoscopic exam, after two weeks, revealed the presence of some larvae at level of gastric mucosa. The laparoscopy performed after two months showed, in two teleosts, hemorrhages and/or nodules on the serosal surface of the intestine. Within each of these changes a single nematode larva was detected. In one case a biopsy was performed from a parasitic nodule. The necropsy was performed a week later and such lesions were sampled for histopathology which confirmed the granulomatous-hemorrhagic nature of the tissue changes. Parasites sampled from *L. caudatus* and *D. labrax* were isolated, fixed in 70% alcoholic solution, morphologically identified by light microscope, after diaphanization with lactophenol, as *A. pegreffii* in both *L. caudatus* and *D. labrax*.

Discussion
This paper represents the first endoscopic and laparoscopic study of an experimentally induced parasitic disease [2,3,4,5]. The evidence of tissue change is an unusual finding in *Anisakis* infected teleost fish. The change here described could be explained because of the high susceptibility of the sea bass towards this parasite, almost never found in wild specimens in Mediterranean, probably in relation to the diet that normally does not include other intermediate hosts. Nevertheless the finding of hemorrhages could also be related to the acute stage of the infection.

References
1 - Bernardi., 2009. Preliminary study on prevalence of larvae of Anisakidae family in European sea bass (*Dicentrarchus labrax*). *Food Control* 20 : 433-434.
2 - Køie M., 2001. Experimental infections of copepods and sticklebacks Gasterosteus aculeatus with small ensheathed and large third-stage larvae of *Anisakis simplex* (Nematoda, Ascaridoidea, Anisakidae). *Parasitol. Res.*, 87 (1): 32-36.
3 - Mlandineo I., 2001. Experimental infection of European sea bass (*Dicentrarchus labrax*) with *Anisakis simplex* third-stage larvae (Nematoda: Ascaridoidea). *Rapp. Comm. Int. Mer Médit.*, 36: 30.
4 - Rolbiecki L., Janc A. and Rokicki J., 2001. Stickleback as a potential paratenic host in the *Anisakis simplex* life cycle in the Baltic Sea: results of experimental infection. *Wiad Parazytol*., 47(3): 257-262.
5 - Smith JW., 1974. Experimental transfer of *Anisakis* sp. larvae (Nematoda: Ascaridida) from one fish host to another. *Helminthol*., 48(4): 229-234.

DISTRIBUTION OF ANCHOVY EGGS IN BOKAKOTORSKA BAY

Milica Mandic [1]* and Slobodan Regner [1]
[1] Institute for marine biology - mamilica@ac.me

Abstract

Anchovy, *Engraulis encrasicolus* (L.), is a pelagic species, widely spread in Mediterranean as well as in the Adriatic Sea. In this paper distribution of anchovy eggs in Boka Kotorska Bay (Southern Adriatic) is presented. The survey was performed at 18 stations in summer 2006, as a part of the project of ichthyoplankton investigation in Montenegrin waters.

Keywords: Ichthyoplankton, Adriatic Sea

Introduction

Anchovy (*Engraulis encrasicolus*, L., 1758) is one of the most important small pelagic fish species in Adriatic Sea. Anchovy eggs are pelagic and frequent in plankton from April to September, with peak in June-July. Maximum numbers of eggs occur in the open Adriatic earlier than in the coastal neritic waters [1, 2]. The aim of this paper was to present the distribution of the anchovy eggs in Boka Kotorska Bay during the period of spawning.

Materials and methods

Ichthyoplankton samples were collected in Boka Kotorska Bay in July 2006, by vertical tows of the PairOVET (modified CalVet) plankton net. Diameters of net cylinders were 25 cm each, and total mouth area was 0.098 m^2, while mesh size was 0.160 mm. Net was towed vertically with the speed of 0.5 m/sec^{-1}. 18 vertical plankton hauls were performed. Maximal depth of sampling was 55 m. At every station data on temperature and salinity, from the surface to the maximal depth attained, were collected by CTD probe. The samples were preserved in 2.5% solution of buffered formaldehyde. Maximal depths of hauls ranged from 12-50 m. Anchovy eggs were removed from the samples, staged and aged using methodology given in [2]. Average temperature from 0 to 20 meters was used to estimate of duration of the egg stage from spawning to hatching [2]. Thus, quantities of anchovy eggs at every station were expressed as number of eggs produced per $m^2 * day^{-1}$.

Results and discussion

Diameter of anchovy eggs (longer axis) ranged from 1.15-1.4 mm. Average production of eggs at all positive stations was 61eggs/ $m^2 * day^{-1}$. The distribution of eggs in the Bay is presented in Figure 1. Maximal production of the eggs was recorded in internal part of the Boka Kotorska Bay (Kotor Bay), while their number gradually decreased towards the entrance of the Bay.

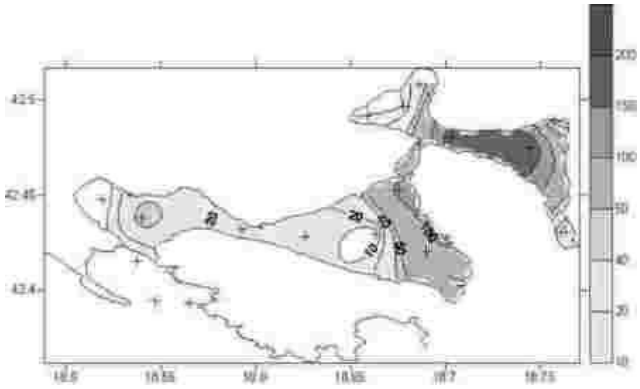


Fig. 1. Distribution of anchovy eggs ($N/m^2 * day^{-1}$)(L.) in Boka Kotorska Bay

Temperature ranged from16.98-23°C, while salinity ranged from 35.01-39‰. These ranges coincide very well with long-term data on temperature and salinity ranges of anchovy spawning in the Adriatic Sea [1, 2]. High spawning intensity in the internal part of the Bay may be explained by the influence of the fresh waters in that shallow area, which cause high organic production. Finally, spatial distribution of eggs found in this survey is in very good accordance with the spatial distribution found in July 1968 [3].

References

1 - Regner, S., 1972. Contribution to the study of the ecology of the planctonic phase in the life history of the anchovy in the Central Adriatic. *Acta Adriat*., 14 (9): 40p.

2 - Regner, S., 1985. Ecology of planktonic stages of the anchovy, Engraulis encrasicolus (Linnaeus, 1758), in the central Adriatic. *Acta Adriat*., 26(1), Series Monographiae, 1:1-113p.

3 - Merker, K. and M. Vujoševic., 1972. Densitê et disposition des oeufs d'anchois (*Engraulis encrasicolus* L.) dans le Golf des Bouches de Kotor. Bay. (in Serbian). Poljoprivreda i šumarstvo, 18(2): 15-27.

BENTHIC PROKARYOTIC AND MACROFAUNAL COMMUNITIES IN THE DEEP IONIAN AND AEGEAN (MEDITERRANEAN SEA) AND IN THE GALICIA BANK (ATLANTIC OCEAN)

Elena Manini [3], Elisa Baldrighi [2], Alessandra Conversi [1] and Stefano Aliani [1]*
[1] CNR ISMAR SP - stefano.aliani@ismar.cnr.it
[2] UNIVPM
[3] CNR ISMAR AN

Abstract
Relationship between depth and food availability vs prokaryotes and macrobenthos in deep (1200 to 5000m depth) central-east Mediterranean and Galicia Bank (Atlantic) is explored. Prokaryotic abundance was from 0.1 to 1.1 x108 cells g-1 i.e. 0.2 and 3.1 µgCg-1. The prokaryotic C production in the Atlantic was 7,7 to 104,6 ngCg-1 h-1. Archaea (9-36% Crenarchaeota, 4-15% Euryarchaeota) were on average 31% of total abundance. Positive correlation between prokaryotic abundance and food availability was in the Galicia bank. Mediterranean macrofauna was from 14±16 to 284±44ind/m2 and from 0,03±0,02 to 0,25±0,05g/m2 and was dominated by polychaetes. Its standing stock decreased with depth, prokaryotic abundance and biomass did not. Large organisms were more affected by loss in available energy with depth.
Keywords: Deep Sea Ecology, Biodiversity

Introduction
The deep-sea is the largest ecosystem on Earth and one of the least studied, with a variety of habitats that support one of the highest biodiversities on the planet [1]. Only a very small fraction of the deep sea has been explored to date and this gap in knowledge has been recognised by the *Census of Marine Life*. However, in parallel with the development of new technologies, industries such as deep-sea fisheries and oil exploitation at entering deep waters, start affecting an ecosystem largely unexplored and highly vulnerable because of the long life and late maturity of many deep-sea species [2]. Additionally, recent studies show that climate change also affects biodiversity and population dynamics in deep-sea ecosystems, although these processes remain largely unknown [3, 4, 5]. In this study we wanted to investigate the importance of depth and food availability for the deep prokaryotic and macrobenthic communities of the central- eastern Mediterranean sea and Atlantic ocean. For this purpose we analysed i) the distribution of prokaryotes' abundance, biomass, community structure, C production, degradation activities of extracellular enzymes; ii) the macrobenthic abundance, biomass and diversity in different deep sea sites of the central-eastern Mediterranean basin; iii) the quality and quantity of sediment organic matter in influencing prokaryotic and macrofaunal communities.

Methods
We compared areas at similar depths with different levels of productivity in the Ionian and Aegean seas (Mediterranean) and in the Galicia Bank (Atlantic). In June and October 2008 a total of 27 deployments of box corer (3 replicates per station) were performed at depths ranging from 1200 to 5000 m. For prokaryotic counts, community structure, prokaryotic activity (extracellular enzymatic activities and carbon production) and organic matter analysis, three sub-core were sectioned (0-1 cm layer) and processed.

Results and Discussion
The distribution of the prokaryotic abundance in the top 1 cm among sites ranged from 0.1 to 1.1 x 10^8 cells g^{-1} equivalent to 0.2 and 3.1 µgC g^{-1}, which are values lower than those found in previous studies; but the prokaryotic C production in the Atlantic was high (from 7,7 to 104,6 ngC g^{-1} h^{-1}) and comparable to those generally found in shallower systems. The percentage of Archaea in the prokaryotic community was on average 31% of total prokaryotic assemblage, unusually higher than values reported for deep sea sediments. Bacteria accounted the remaining portion (69% of total abundance). Archaeal assemblages were dominated by Crenarchaeota (9-36% of total Archaeal abundance) followed by Euryarchaeota (4-15%) and a small percent of unidentified Archaea. Multiple Regression Analysis evidenced a positive correlation between prokaryotic abundance and food availability only in the Galicia bank; the bacterial domain from these areas was strongly related to Biopolymeric C content. Prokaryotes in the deep Mediterranean may be affected by other factors than simply food availability. Macrofaunal abundances and biomass were generally low, from 14±16 to 284±44 ind/m^2 and from 0,03±0,02 to 0,25±0,05 g/m^2 and dominated by polychaetes in almost all stations but one dominated by crustaceans. Cnidaria and Crustaceans were the second dominant groups but unevenly distributed among stations; a more structured community was in the shallowest station where molluscs and sipunculida, were also found. Most of the polychaetes were deposit-feeders, as often when organic matter is refractory to degradation processes. Species richness (average S=4) and Shannon diversity (average H'=0.6) values were low but individuals were equally distributed among different families (average Eveness = 0.9). Abundance and biomass of macrobenthos decreased with depth (R^2=0.91) but increased with the content of phytodetritus into the sediments (R^2=0.93 and R^2=0.82); biopolymeric compounds did not show valid statistical relationships. A clear depth-related pattern was not found in prokaryotic abundances, and bacterial carbon production. The detrital organic matter of the sediments had a significant correlation with prokaryotes only in the stations in the Galicia Bank. The other factors involved in affecting their distribution, abundances and activities will be further explored. In conclusion, despite the low abundance of microorganisms, the contribution of Archaea was higher than reported until now for marine sediments [6;7]. Also macrofauna abundance and biomass were characterized by very low values and showed a negative correlation with depth, as previously reported [8;9]. Prokaryotic abundance and biomass show no decline with depth and large organisms are very likely affected by the reduction in available energy with depth more than others.

This work was funded by ESF as part of the BIOFUN (EURODEEP project).

References
1 - Tyler, P.A., 2003. Disposal in the deep sea: analogue of nature or faux ami? *Environmental Conservation*, 30 1 pp26-39.
2 - Malmqvist B., Rundle S., 2002. Threats to the running water ecosystems of the world. *Environmental Conservation* 29 pp134–153.
3 - Wall DH, Palmer MA, Snelgrove PVR., 2001. Biodiversity in critical transition zones between terrestrial, freshwater and marine soils and sediments: Processes, linkages and management implications. *Ecosystems* 4pp418–420.
4 - Danovaro R., Gambi C., Dell'Anno A., Corinaldesi C., Fraschetti S., Vanreusel A., Vincx M., and Gooday A.J., 2008. Exponential Decline of Deep-Sea Ecosystem Functioning Linked to Benthic Biodiversity Loss Current Biology 18 pp1–8.
5 - Glover A.G., Smith C.R., 2004. The deep-sea floor ecosystem: current status and prospects of anthropogenic change by the year 2025. Environmental Conservation, 30 3 pp219-241
6 - Danovaro, R., Dell'Anno, A., Fabiano, M., Pusceddu, A., and Tselepides, A., 2001. Deep-sea ecosystem response to climate changes: The eastern Mediterranean case study. Trends Ecol. Evol. 16 pp505–510.
7 - Danovaro, R., Dell'Anno, A., and Pusceddu, A., 2004. Biodiversity response to climate change in a warm deep sea. Ecol. Lett. 7 pp821–828.
8 - Basso D., Thomson J., Corselli C., 2004. Indications of low macrobenthic activity in the deep sediments of the eastern Mediterranean Sea. *Scientia Marina*, 68 (suppl.3) pp 53-62.
9 - Kro¨ncke, I., Tu¨rkay M., D. Fiege D., 2003. Macrofauna Communities in the Eastern Mediterranean Deep Sea. *Marine Ecology*, 24 pp193-216.
10 - Tselepides, A., Papadopoulou, K.-N., Podaras, D., Plaiti, W., Koutsoubas, D., 2000. Macrobenthic community structure over the continental margin of Crete (South Aegean Sea,NE Mediterranean). *Progress in Oceanography*, 46 pp401-428.

AGE, GROWTH AND AGE AT SEXUAL MATURITY OF THE LONGNOSE SPURDOG, *SQUALUS BLAINVILLEI*, IN THE GULF OF GABES (TUNISIA)

S. Marouani [1]*, H. Kadri [1], B. Saidi [1], A. Bouain [2] and M. N. Bradai [1]
[1] Institut National des sciences et technologies de la mer (Centre de Sfax) - sondesmarouani@yahoo.fr
[2] Faculté des sciences de Sfax BP.802 – 3018 Sfax

Abstract
The age and growth data of *Squalus blainvillei*, in the Gulf of Gabès, derived from spines reading, were used to estimate the von Bertalanffy parameters: $L\infty$ =105.7cm, K= 0.11, t0 =−1.12 for females and: $L\infty$ = 91.1 cm, K= 0.14, t0 =−1.42 for males. Ages at maturity for females and males were 7.44 and 4.79 years respectively. The maximum age was 19 years.
Keywords: Growth, Elasmobranchii, Gulf Of Gabes

Introduction
Longnose spurdog *Squalus blainvillei* occurred throughout the Mediterranean Sea up to 700 m depth [1]. Data on its age and growth were scarce in the Mediterranean Sea except those of the Sicilian Channel [2]. Life history parameters, mainly age and growth, are essential for adequate management of shark catches. Thus the aim of this work is to estimate age and growth of *S. blainvillei* using spines.

Materials and methods
115 specimens of *S. blainvillei* fished in the Gulf of Gabès were sampled from May 2004 to July 2005. The second dorsal fin spines (DFS) were removed and prepared [3]. Growth bands were counted in each spine section throughout a specific line transept within the internal dentine layer and using a Microscope and Olympus S2X9 stereomicroscope at x 20 magnification; a band was defined as a pair of dark (opaque) and light (translucent) concentric rings [3]. The TL-at-age data were fitted to the von Bertalanffy growth model (VBGM).

Results and discussion
The total number of bands counted increased with length for both males and females. Estimated parameters of the von Bertalanffy equation were shown in tab 1.

Tab. 1. Growth parameters and age of *S. blainvillei*

Location	Sicilian Channel (Cannizzaro *et al.* 1995)		Gulf of Gabès (Present study)	
Method	vertebral band count		Internal dorsal spine band count	
Sex	♀	♂	♀	♂
L^{∞}: theoretical asymptotic length (cm)	117.9	96.0	105.7	91.1
K: growth rate coefficient(year -1)	0.10	0.13	0.11	0.14
To: theoretical age at zero length (years)	-1.38	-1.39	-1.12	-1.42
A. mat : age at maturity (years)	5.1	3.3	7.44	4.79
A. max: oldest fish (years)	8	8	19	15

Until 8 to 10 years, males grew more quickly than females. After that, females continued to grow faster (Fig. 1). The age at maturity was estimated respectively for females and males at 7.44 and 4.79 years. As shown in table 1, *S.blainvillei* reached a maximum age more important in the Gulf of Gabès than in the Sicilian Channel. These differences may be related to the structure used (spines or vertebrae), the variability between readers, the stock state and fishing pressure and to species confusion, it seems in fact that both *S. blainvillei* and *S. megalops* occurs in the same area.

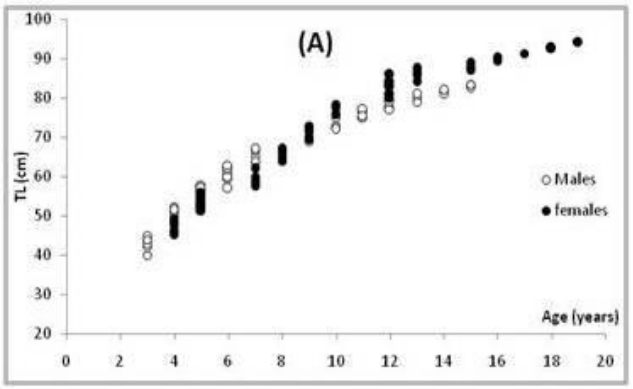


Fig. 1. Von Bertalanffy growth curve in length of *S. blainvillei* from the Gulf of Gabès

References
1 - Bradaï, M. N., Saïdi, B., Ghorbel, M., Bouaïn, A., Guélorget, O. & Capapé, C., 2002. Observations sur les requins du golfe de Gabès (Tunisie méridionale, Méditerranée centrale). Mésogée, 60, 61-77.
2 - Cannizaro, L., Rizzo P., D. Levi, and S. Gancitano., 1995. Age determination and growth of *Squalus blainvillei*, (Risso, 1826). *Fish. Res*., 23: 113-125.
3 - Irvine, S. B., 2004. Age, growth and reproduction of deepwater dogfishes from southeastern Australia. Ph.D. Thesis, Deakin University, Warrnambool.

NEW FINDINGS OF THE RARE BLACK BRITTLESTAR *OPHIOCOMINA NIGRA* (ABILDGAARD, IN O.F. MULLER, 1789) (ECHINODERMATA, OPHIACANTIDAE) IN THE SICILIAN CHANNEL

D. Massi [1]*, G. Sinacori [1], A. Titone [1], R. Micalizzi [1] and P. Rinelli [2]

[1] Istituto per l'Ambiente Marino Costiero Consiglio Nazionale delle Ricerche V. L. Vaccara 61 – 91026 Mazara del Vallo (TP) Italy - giuseppe.sinacori@iamc.cnr.it

[2] Istituto per l'Ambiente Marino Costiero Consiglio Nazionale delle Ricerche Spianata San Raineri 86 - 98122 Messina Italy

Abstract

Fourteen specimens of *Ophiocomina nigra* were collected in a restricted area of the Sicilian Channel under the influence of Atlantic Ionian Stream, between 64 and 97 m depth. The species was associated with the sea urchin *Stilocidaris affinis* (Philippi, 1845), a species "characteristic" of the Coastal Detriticus biocenosis. The Sicilian Channel represents the eastern border of the species occurrence in the Mediterranean.

Keywords: Echinodermata, Biogeography, Sicilian Channel

Ophiocomina nigra (Abildgaard, in O.F.Muller, 1789) is a brittle star living in the eastern Atlantic from the Azores to northern Norway and rarely in the western Mediterranean [1]. A first synthesis of Mediterranean distribution was given in [2], the species occurring in waters off Sicily, Algeria, Tunisia, Baleares, France and Catalonia. Further records were reported along the southern Spanish coasts [3]. More recently, the species was confirmed in Sicily (South Tyrrhenian Sea) [4] and off the Maltese Islands [5, 6]. Our specimens were collected within the European Data Collection Framework (Reg. CE 199/2008) during the trawl surveys (MEDITS and GRUND) and the sampling of the commercial trawling discard (DISCARD). The main information on the records is reported in Table 1.

Tab. 1. Main information on the new findings of *O. nigra* in the Strait of Sicily

Survey	Date	Appr. Lat.	Appr. Lon.	Depth (m)	N individuals
MEDITS 2008	13/05/2008	37°23.2'	12°11.4'	64-67	1
GRUND 2008	09/11/2008	37°29.6'	12°00.4'	97-96	1
GRUND 2008	10/11/2008	37°11.9'	12°12.5'	66-69	1
GRUND 2008	10/11/2008	37°12.9'	12°07.9'	76-80	1
MEDITS 2009	22/05/2009	37°11.3'	12°12.6'	67-72	9
DISCARD 2009	30/01/2009	37°12.0'	12°12.0'	10-150	1

The reported findings occurred in a limited area between 64 and 96 m on the external border of the Adventure Bank in front of Pantelleria Island (western side of the Sicilian Channel). The species was associated with the sea urchin *Stilocidaris affinis* (Philippi, 1845), a species "characteristic" of the Coastal Detriticus biocenosis (CD). The *O. nigra* distribution in the Mediterranean suggests a strong link with the Atlantic water (AW) [2], the Sicilian Channel representing the eastern border of the species occurrence in the Mediterranean.

References

1 - Tortonese E., 1965. Echinodermata - Fauna d'Italia, VI. Ed. Calderini, Bologna, pp 1-422.

2 - Allain J.Y., Romano J.Cl., Semroud R., 1978. *Ophiocomina nigra* (O.F. Muller) (Echinodermata, Ophiuroidea) dans la region d'Alger. *Pelagos*, 5: 50-64.

3 - Ocana A., De La Morena I., Moriana M., Alonso M.R., Ibanez M., 1982. Algunos Equinodermos de la costa de Malaga (Mar de Alboran). *Inv. Pesq*., 46 (3) : 433-442.

4 - Rinelli P., 1998. A synthesis of the Echinoderm Fauna of the Tyrrhenian Sea. *Rapp. Comm. int. Mer Médit.*, 35: 484-485.

5 - Tanti C.M., Schembri P.J., 2006. A synthesis of the Echinoderm Fauna of the Maltese Islands.*J. Mar Biol. Ass. U.K.*, 86: 163-165.

6 - Mifsud C., Taviani M., Stohr S., 2009. Remarks on Echinodermata from the South Central Mediterranean Sea based upon collections made during the MARCOS cruise (10 to 20th April, 2007). *Medit. Mar. Sci.*, 10 (2): in press.

FEEDING HABITS AND TROPHIC STATUS OF MEDITERRANEAN MORAY EEL, *MURAENA HELENA* L. 1758 IN THE ADRIATIC SEA – PRELIMINARY APPROACH

S. Matic-Skoko [1]*, P. Tutman [1], E. Marcelja [2], D. Skaramuca [2], D. Đikic [3], D. Lisicic [3] and B. Skaramuca [2]
[1] Institute of Oceanography and Fisheries, Split, Croatia - sanja@izor.hr
[2] University of Dubrovnik, Department of Aquaculture, Dubrovnik, Croatia
[3] University of Zagreb, Department of Animal Physiology, Faculty of Science, Zagreb, Croatia

Abstract
The feeding habits of *Muraena helena* from Adriatic Sea were studied using frequency of occurrence, numeric and gravimetric percentage, an index of relative importance (IRI), main food index (MFI) and coefficient of nutritiveness (Q). *M. helena* is a carnivore, mainly piscivore with a trophic level of 4 and up. Diet composition including 14 different prey taxa was evidently homogenous among *M. helena* size groups. Principal prey items by decreasing importance were Pisces and Decapoda. The study will be completed by analysing dietary overlap among size groups and seasons.
Keywords: Adriatic Sea, Fishes, Diet

Species from Muraenidae family are relatively big group of fishes famous by their lurking in holes, and writhing snakelike through crevices, under rocks or corals and by ability to swallow very huge prey [1]. *M. helena* is common in eastern Atlantic and Mediterranean. Two moray species are found in Adriatic Sea: very rare *Gymnothorax unicolor* and more common *M. helena*, both with minor commercial importance.

While other morays are carnivores that feed on fish, crabs and octopus with a significant role in population dynamics of many demersal fish [2], very little is known about the biology of *M. helena* and of its ecological role in Adriatic coastal ichthyocommunities.

A total of 267 individuals of *M.helena* were caught in the Southern Adriatic (42°38' 51,72" N; 18° 02' 43,57"E) by bottom long-line. Prior to alimentary tract removal, fish were weighed and measured. The tracts were individually stored in 4% formaldehyde. The alimentary tracts were opened and prey items were separated using a binocular microscope (magnification 10-60x). The number of empty tracts was recorded. Prey items were counted, weighted and identified to the lowest possible level. The weight of items was obtained by wet weight method. Whenever fragments were found, the number of individuals was determined as the lowest possible number of individuals from which fragments could have originated.

Three indices were used to describe the diet, these were: the frequency of occurrence (%F), percent numbers (%N) and weight (%W) [3]. The index of relative importance IRI = (% N + % W) * %F was calculated for each prey category as proposed by [4]. For diet comparisons, the %IRI for each food category was applied after grouping prey taxa into categories based on their taxonomy and ecology. Main food Index (MFI) by [5] and coefficient of nutritiveness (Q) by [3] were also computed. Three size groups were determined: 25 - 50 cm; 50 - 75 cm; 75 -100 cm. In ecology, the trophic level is the position that an organism occupies in a food chain - what it eats, and what eats it. Each link in this chain of consumption is termed a trophic level. Because only a fraction of the energy used by a level is converted to biomass, less energy is available at higher levels. Primary producers often have trophic level 1. There is no in-principle limit to the number of levels in a trophic system, but as only a fraction of the energy of each level can be processed by the next (10%), trophic systems with more than five levels of consumption are exceptional.

The stomach contents of *M. helena* (total length 27.5 - 100.0 cm; total weight 116.1 - 2280.0 g), were examined of which all were full. Recognizable preys of 14 different taxa were identified and grouped in 6 classes and values of IRI, MFI and Q for them are presented in Table 1. Diet was evidently homogenous among *M. helena* size groups. The diet of *M. helena* consisted of a wide variety of macrobenthos. Pisces, occurring in 2/3 of all stomachs dominated in the diet. Crustacea and Mollusca followed this group in frequency of occurrence and weight. Decapoda represented 21.1% of occurrence in all stomachs. The principal prey found were Pisces (IRI=9755.8) with dominant species *Phycis phycis* (IRI=714.1) that was found in 11.54% of stomachs and Crustacea (IRI=913.0) including more important species as *Pilimnus hirtellus* (IRI=44.7) and *Galathea strigosa* (IRI=20.2). Besides Algae, other groups were represented with approximately 2% in total stomachs contents. It is evident that Pisces are most frequent as prey in numbers and weight, they have highest index of relative importance, and besides Crustacea they represented main type of food and have the highest nutritive value, while Algae, Gastropoda, Bivalvia and Remains were secondary or accidental food. Of total analyzed stomachs, 50% were those of which the content was not possible to identify, so we classified it as digested fish material remains. Due such results, *M. helena* have a trophic level 4.2 ± 0.61 (SE) by main prey types in nutrition, which were fishes and crabs with trophic level 2.8 and up.

Tab. 1. Diet composition of *Muraena helena*, Adriatic Sea (F is frequency of occurrence; N is numerical composition; W is gravimetric composition; IRI is index of relative importance, MFI is main food index and Q is index of nutritiveness)

Food items	%F	%N	%W	IRI	MFI	Q
ALGAE	4	3.85	0.14	15.96	0.56	0.55
GASTROPODA	2	1.92	1.92	7.68	3.76	3.69
BIVALVIA	2	1.92	0.96	5.77	1.88	1.85
POLYCHAETA	2	1.92	10.36	24.58	20.33	19.93
CRUSTACEA	22	21.15	20.35	912.99	438.99	430.39
PISCES	72	69.23	66.27	9755.82	4679.46	4587.70

Only [6] reported results of *M. helena* feeding habits (zoobentos, nekton, benthic crabs, crustacean, squids and octopus) and its findings are in agree with our results in all except by non presence of cephalopods. But, at this preliminary degree, all our samples are not analyzed till this moment (only two seasons are processed and diet may strongly vary seasonally). Moreover, high percentage of unidentified prey was present and will be carefully examined once again in terms of finding structures which may belong to other animal components.

The index of relative importance (IRI) is a frequently used to estimate diet composition, but it has disadvantages due impact to its key components. Percent frequency of occurrence (%F) does not account number and weight of the prey item. Numeric percentage (%N) does not account weight and frequency of occurrence. Consequently, %N is highly influenced by very small, but numerous preys while very rare and large prey can underline % W. Also, the results in terms of relative importance of different prey groups should be treated with caution. Some prey items that are small, soft and rapidly digested may be underestimated, while large prey with durable hard parts may be given undue importance.

Piscivorius, agressive species as *M.helena* are less influenced by abundances of specific prey taxa then are for example more specialized feeders [1] [2]. The ecological importance of this species within the mediterranean coastal communities appears to be significant and further studies are needed to assess it. Those findings will lead to the implementation of multispecies approaches to the management of Mediterranean artisanal fisheries.

References
1 - Randall J.E. and Golani D., 1995. Review of the moray eels (Anguilliformes: Muraenidae) of the Red sea. *Bull. Mar. Sci*., 56(3): 849-880.
2 - Hiatt R.W. and Strasburg D.W.,1960. Ecological relationships of the fish fauna on coral reefs of the Marshall Islands. *Ecol. Monogr*., 30(1): 65-127.
3 - Hureau J.C., 1970. Biologie comparée de quelques Poissons antarctiquues (Nototheniidae). *Bull. Inst. Océanogr. Monaco*, 68 (1391): 1- 244.
4 - Pinkas L., Olhiphant M.S. and Iverson I.L.K., 1971. Food habits of albacore, bluefin tuna and bonito in California waters. *Fish Bull*., 152: 1-105.
5 - Zander C.D., 1982. Feeding ecology of Littoral Gobiid and Blennioid fish of the Banyuls area (Mediterranean Sea) I. Main food and tropic dimension of niche and ecotope. *Vie et Milieu*, 32 (1):1-10.
6 - Göthel H., 1992. Guide de la faune sous-marine: La Méditerranée. Invertébrés marins et poissons. Eygen Ulmer GmbH & Co., 318 p.

STATE AND PERSPECTIVE OF *SCORPAENA SCROFA* AND *MULLUS SURMULETUS* – TWO HIGHLY VALUED SPECIES OF EASTERN ADRIATC ARTISANAL FISHERIES

Sanja Matic-skoko [1]*, Nika Staglicic [1] and Armin Pallaoro [1]
[1] Institute of Oceanography and Fisheries - sanja@izor.hr

Abstract
The state and perspective of two main target species of Croatian artisanal fisheries: largescaled scorpionfish, *Scorpaena scrofa* and striped red mullet *Mullus surmuletus* were investigated by detailed analysis of experimental catches. Basic demographic characteristics of those species and recommendations for sustainable use of coastal resources are presented.
Keywords: Adriatic Sea, Fisheries, Coastal Management

Introduction
Croatian artisanal fisheries takes place in a relatively small area which corresponds to about 6% of the Croatian Adriatic total fishing grounds. Nevertheless, it generates a substantial yield taking second place in the overall catch statistics, indicating that coastal area is subjected to high level of exploitation. As a biologically diverse and lush area Vis aquatorium has historically been one of the most important eastern Adriatic fishing grounds, especially for highly valued species such as largescaled scorpionfish, *Scorpaena scrofa* and striped red mullet, *Mullus surmuletus*. Therefore, it was chosen as a pilot area where we assessed in detail the status of the two aforementioned fish species.

Material and methods
Largescaled scorpionfish, *S. scrofa* and striped red mullet, *M. surmuletus* were caught by employing 'poponica' - trammel bottom sets with standard construction characteristics.

Results
S. scrofa specimens ranged between 14 - 45.1 cm total length (average 24 cm) and 30-1347 g weight (average 273.33). Scale reading of caught specimens gave the age range of 3-8 years. Assessing the destructiveness of 'poponica' nets for *S. scrofa* population by taking into account minimal landing size of this species (25 cm) ordained by [3] it can be seen that the overall catch is dominated by undersized specimens (62.5%) (Fig.1). Situation is even more concerning if biologically justified size at first sexual maturity is applied (TL 30 cm). The proportion of immature specimens is in that case as high as 90%. All of the above-mentioned indicates a rather alarming status of *S.scrofa* populations.

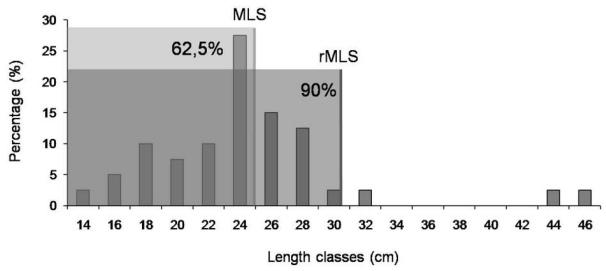


Fig. 1. Length frequency distribution of *Scorpaena scrofa* catch from trammel nets, Adriatic Sea (MLS – minimal landing size; rMLS – recommended minimal landing size)

In wider Vis aquatorium area a high number of *M. surmuletus* specimens were caught in trammel nets due to the fact that most of fishing operations have taken place during the warm summer-autumn period when this species comes closer to shore for feeding and is therefore more easily caught. Total length, weight and age ranges of caught specimens are 17-30.9 cm (average 24.12 cm), 33-337 g (average 159.2 g) and 3-6 years, respectively. Taking into account minimal landing size of this species (11 cm) ordained by [3] no undersized specimens were present in the overall catch. Even when demersal long line destructiveness is assessed considering biologically justified size at first sexual maturity (18 cm), then catches contained a rather low, satisfying 1.2% of immature specimens.

Discussion
Negative impacts related solely to fishing activities of those target species are as follows: decline in total CPUE (average CPUE with unit effort being one 32 m long trammel net is 0.66-3.31 kg/net), increase in the CPUE of Scorpaenidae family (the incline is, however, mostly due to *S. porcus* and not to commercially more valuable *S. scrofa*); decrease in average catch length and weight of targeted fish and increased proportion of immature specimens.
Nevertheless, the situation is quite favourable in the project area when compared to any other in the Adriatic. However, it is not without concern. Namely, looking at biometry characteristics of commercially important species S. scrofa and M. surmuletus, it is evident that large specimens are only rarely caught. Average landing sizes are more than twice smaller than those maximally attainable.
Changes in quantitative and qualitative catch structure of coastal fish populations can be due to various reasons. It is generally acknowledged they are mainly due to intensive fishing. However, different species vulnerability to fishing activities, density dependent effects as a result of complex ecological relationships in coastal communities, predation, growing marine pollution and climate change all play a part [4].
Regarding the fishing gear used for catching fore mentioned target species, it can, first of all, be said that trammel net 'poponica' is highly nonselective and its use coincides with reproduction period of most species. Other used gillnets are selective and generally catch adult specimens if are not misused. Recommendation therefore, is a more responsible conduct encouraged by a more efficient surveillance. Temporal restriction should be considered in order to allow undisturbed reproduction of targeted species. It is necessary to increase minimal landing size of 11 cm for *M. surmuletus* because in [3] this value is given for both Mullidae species. In order to insure sustainable small-scale coastal fisheries, all of the aforementioned issues need to be taken into consideration. Most importantly continuous monitoring and effective implementation of existent regulation measures should be established.

References
1 - Jardas I., Pallaoro A., Kraljevic M., Dulcic J. and Cetinic P., 1998. Long-term changes in biodiversity of the coastal area of the Eastern Adriatic: fish, crustacean and cephalopoda communities. *Period. Biolog.*, 100 (1): 19-28.
2 - Morovic D., 1970. Trammel bottom set catches and their analyses from a biological viewpoint. *Morsko ribarstvo*, 3: 119-121.
3 - Official Gazette No. 101/2002. Fish and Other Sea Organisms Protection Decree.
4 - Willis T.J. and Anderson M.J., 2003. Structure of cryptic reef fish assemblages: relationships with habitat characteristic and predator density. *Mar. Ecol. Prog. Ser.*, 257: 209-211.

GENETIC STRUCTURE OF *POMATOSCHISTUS MARMORATUS* (GOBIIDAE) IN MEDITERRANEAN SEA

Randa Mejri [1]*, Sabrina Lo brutto [2], Oum kalthoum Ben hassine [1] and Marco Arculeo [2]
[1] Unité de Recherche de Biologie, Ecologie et Parasitologie des Organismes Aquatiques. - ran.mej@gmail.com
[2] Dipartimento di Biologia Animale, Università di Palermo via Archirafi, 18-90123 Palermo, Italy.

Abstract
In this work, the *mt* DNA marker has proven its usefulness as informative source of genetic variation by the identification of four population units of *Pomatoschistus marmoratus* and by delineating their boundaries.
Keywords: Genetics, Eastern Mediterranean, Western Mediterranean, Fishes

Introduction
The genetic population structure of marine species is shaped in space and time by the combined impacts of their historical events and the complex interactions of biology, geography, and climatic shifts [1]. Hence, the identification of these ecological and evolutionary factors that control local differentiation of populations is crucial in order to understand fine-scale micro-evolutionary processes [2] and to examine the spatial and temporal scales at which populations are genetically structured. Previous studies have suggested significant population structuring in the Mediterranean Sea (MS) in relation to some of the factors listed above and which trigger intraspecific fragmentation. Some of these numerous phylogeographic studies have a great focus on Gobiid species well distributed and diversified in the MS. Among these numerous species, the marbled goby *Pomatoschistus marmoratus* (Risso, 1810), which is a strictly inhabiting lagoons species and a poor dispersers one. In this study, a thorough analysis of the genetic variation of *P. marmoratus* at different geographic scales and across much of its distribution area, is presented and discussed. Its phylogeography was inferred using mtDNA 16S ribosomal RNA gene (16S-rRNA) and Cytocrome Oxidase I gene (COI) sequences and, a robust statistical framework of hypothesis for characterizing the present and past population genetic of this goby. Using this organism as a model, we test how physical and evolutionary factors lead to the structuring of marine populations in MS.

Materials and Methods
A total of 56 marbled gobies were sampled from eight Mediterranean localities (Three sites from western Mediterranean: Thau lagoon, and Vaccarès lagoon, in Southern France, Bizerta lagoon, in Northern Tunisia; five sites from eastern Mediterranean, subdivided in the following areas: two samples from Lybico - Tunisian Gulf, Lella el Hadria lagoon, and El Biban lagoon, in Southern Tunisia, two samples from Adriatic Sea, Venice lagoon, in Northern Italy and Soline Bay, in Croatia, and one sample from Aegean Sea, Vassova lagoon, in Greece). A fragment of the mitochondrial 16S-rRNA gene (501 bp in length) was amplified with the universal primers H16 and L16. A fragment of the *mt*DNA COI gene (647 bp in length) was amplified using the universal primers FishF1 and FishF2. Sequencing results were manually edited with BioEdit program version (7.0.5.3) and aligned using the CLUSTAL-W program. Phylogeographical and molecular evolutionary analyses were performed for each separate gene and considering all data together. Phlogenetic analyses were conducted using PAUP 4.0b10, DNAsp v.4.50 and ARLEQUIN v.3.11. Levels of *mt*DNA diversity and population genetic statistics were investigated by comparing population estimates of mitochondrial haplotype diversity (Hd), nucleotide diversity (π), number of segregating sites (SS) and gene flow (F_{ST} and N_em). To examine hierarchical population structure as well as the geographical pattern of population subdivision, we used analysis of molecular variance (AMOVA). In addition, we carried out SAMOVA (Spatial Analysis of MOlecular VAriance) using the program SAMOVA.1.0. Besides, an unrooted network of *mt*DNA haplotypes was constructed using the program TCS 1.13 with 95% parsimoniously plausible branch connections between haplotypes. This statistical parsimony network (SPN) method was used because analyses based on networks are thought to be more accurate at representing historical processes.

Results and discussion
Pomatoschistus marmoratus shows a remarkable degree of genetic population subdivision and phylogeographic complexity within the MS. Sequences show a tendency to gather by sampling locality providing four clusters matching the geographical positions. These phylogroups appeared as monophyletic with high bootstrap support values equal to 100%. According to the geographic locations of the specimens in each major clade, our mitochondrial DNA analysis of *P. marmoratus* in the Mediterranean revealed a west–east phylogeographic split involving four highly divergent phylogroups with no geographical overlap. Each of these lineages roughly corresponds to a different Mediterranean sub-basin. We designated the four clades as Western Mediterranean Sea, Lybico Tunisian Gulf, Adriatic Sea and Aegean Sea. These four clades are disconnected also in the SPN and constitute the most probable and only statistically significant grouping in the Samova analysis. Pairwise FST values were generally high and well significant within the four clades and the Nem was very low and does not exceed 0.06 migrant per generation suggesting that the gene flow between the four clades is almost absent. The networks of the LTG and AEG clades showed evidence of star-like phylogenies, suggestive of past demographic expansions; however, the WMED and ADR networks suggest an equilibrium status. Looking at the biology and life history of the studied fish, the past geomophological processes and the hydrographic patterns within the MS we can understand the occurrence of this split within the different analysed populations and the lower genetic variability encountered within the different phylogroups. This pattern is consistent with the potential effects on dispersion of the Siculo Tunisian Strait and the Hydrographic isolation of the Adriatic and Aegean Seas where selective forces related to physical, chemical and/or ecological conditions present in each basin could account for the phylogeographical break. The strong currents that limit the mixing of the different bodies' water may interact with the local features and the particular bottom topography of the zone and could have allowed progressive intraspecific genetic differentiation.

References
1 - Hewitt, G., 2000. The genetic legacy of the Quaternary ice ages. *Nature* 405: 907-913.
2 - Manier, M.K., and Stevan, J. Arnold., 2006. Ecological correlates of population genetic structure: a comparative approach using a vertebrate metacommunity. *Proc R Soc B* 273: 3001–3009 .

LENGTH–WEIGHT RELATIONSHIPS OF THE ALIEN JINGA SHRIMP, *METAPENAEUS AFFINIS* (H. MILNE EDWARDS, 1837) (DECAPODA, PENAEIDAE) IN THE MEDITERRANEAN SEA

Gulnur Metin [1]*, Ilker Aydin [1] and Bella s. Galil [2]
[1] Ege University Faculty of Fisheries - gulnur.metin@ege.edu.tr
[2] National Institute of Oceanography, 8030, Haifa 31080, Israel

Abstract
Seasonal length-weight relationships (LWR) of the recently introduced Jinga Shrimp, *Metapenaeus affinis*, population inthe Izmir Bay are presented. A total of 1795 specimens were collected, and LWR for females, males and combined sexes, were calculated as $W=0{,}0046L^{3{,}19}$, $W=0{,}0076L^{2{,}96}$ and $W=0{,}0041L^{3{,}23}$ respectively. Whereas females showed positive allometry, males showed negative allometry.
Keywords: Alien species, Crustacea, Aegean Sea

Introduction
Metapenaeus affinis occurs in the Indo-West Pacific Ocean, from the Persian Gulf and the Arabian Sea, to Indonesia, China, Philippines and New Guinea [1]. The species is commercially of major importance in the Persian Gulf, where it is commonly captured on shallow muddy bottoms. It is raised commercially in the Philippines. It was first noted in the Mediterranean in April 2008, when 64 specimens were caught by trammel net set on muddy bottom, at depth of 8-12 m, at the inner part of Izmir Bay, on the Aegean coast of Turkey [2]. We monitored this population ever since.

Material and Method
A total of 1795 specimens were collected at the inner part of the bay by shrimp trammel net at monthly intervals between November 2008 – October 2009. Sexually mature male and female specimens were collected between May and October. LWR measurements of the newly established population were taken and compared to data from the species native range, and to serve as baseline for possible future studies of possible adaptation to the local environment. The relationship between length and weight was established as $W=aL^b$, where W is total body weight (g), L is total length (cm), and a and b are coefficients [3]. The parameters a and b of length-weight relationships were estimated by linear regression analysis on log transformed data. The association degree between variables was calculated by the determination coefficient (R^2). The growth type was identified by Student's *t*-test.

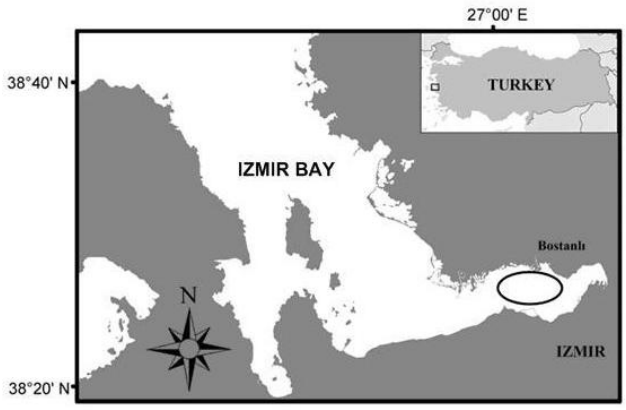


Fig. 1. Sampling area, where specimens were collected

Results and Discussion
Total length varied between 8-17,5 (±1,34) cm and weights were 3,2-38,9 (±4,87) gr. The smallest individual was a male collected in May, the largest a female collected in September. The maximum length for males was 14,6 (±1,12) cm as compared with 22.2 cm in its native range [4]. The population shows a normal distribution with sex ratio 1:1.2. Generally females are larger and heavier than males. According to calculations, growth for female and combined sex individuals showed positive allometry, but males showed negative allometry. In addition the slope (b) values revealed differences between the seasons ($p<0{,}05$). There are few LWR data for jinga shrimp. One study estimated $W=0.7079C^{2.770}$ whereas another $W=.0000495L^{2.7867}$ [4, 5]. The introduction of *M. affinis*, and the establishment of a population large enough to be commercially exploited, is a boon for Izmir Bay's artisanal fishermen, who turned from beach seining to trammel netting for prawns. During the summer of 2009, 10-12 fishing vessels were profitably engaged in this fishery, with wholesale price 4.5 euro per kg, and retail at 6.5-7 euro. The population dwindled in August, due possibly to intense illegal fishing.

Tab. 1. Length–weight relationships for, Jinga shrimp

Table. Length–weight relationships for, Jinga shrimp

Sex	*a*	*b*	n	R^2	SE(*b*)
Spring					
F	0,0059	3,09	535	0,93	0,037
M	0,0089	2,89	457	0,9	0,045
Summer					
F	0,0045	3,21	177	0,95	0,054
M	0,0082	2,93	176	0,89	0,076
Autumn					
F	0,0044	3,21	166	0,98	0,034
M	0,0117	2,8	138	0,96	0,049
Winter					
F	0,0047	3,19	108	0,93	0,082
M	0,0102	2,85	38	0,96	0,092
Total					
F	0,0046	3,19	986	0,96	0,021
M	0,0076	2,96	809	0,95	0,023
T	0,0041	3,23	1795	0,96	0,016

a, intercept; b, slope; n, number of examined specimens; R^2, correlation coefficient; SE(b), standard error of b.

>

References
1 - Miquel, J.V., 1982. Le genre *Metapenaeus* (Crustacea, Penaeidae): taxonomie, biologie et pêches mondiales.*Zool. Verhand., Leiden, 195: 1-137.*
2 - Aydin, I., K., Bakir, B. S., Galil., 2009.The first record of the Jinga shrimp *Metapenaeus affinis* (H. Milne Edwards, 1837) (Crustacea: Decapoda: Penaeidae) from the Mediterranean Sea. Crustaceana 82 (8): 1091-1095.
3 - Ricker, W.E., 1973. Linear Regressions in Fishery Research. *Fish. Res. Board Can*. 30, 409–434.
4 - Hall, D.N.F., 1962. Observations on the taxonomy and biology of some Indo-West Pacific Penaeidae (Crustacea, Decapoda). *Fish.Publs colon.Off*., 17:229 p.
5 - Subrahmanyam, C. B., 1967. Notes on the bionomics of the penaeid prawn *Metapenaeus affinis* (Milne Edwards) of the Malabar coast. *Indian Journ. Fish*., (A) 10(1): 11-22.

AGE AND GROWTH OF FATTENING BLUEFIN TUNA (*THUNNUS THYNNUS* L., 1758) IN THE EASTERN MEDITERRANEAN SEA

Nicky Milatou [1]* and Persefoni Megalofonou [1]

[1] Department of Zoology and Marine Biology, Faculty of Biology, University of Athens, Greece - nmoceanology@msn.com

Abstract

A total of 188 specimens of bluefin tuna (*Thunnus thynnus* L., 1758) were sampled from the Greek Bluefin Tuna farm, in the Ionian Sea, between December 2007 and January 2008. The samples ranged from 127 to 272 cm in fork length and from 43 to 475 kg in round weight. Their age was estimated from 5 to 16 years, using caudal vertebrae and the length-weight relationship revealed a positive allometric growth.

Keywords: Eastern Mediterranean, Aquaculture, Growth, Pelagic, Teleostei

Introduction

Bluefin tuna (*Thunnus thynnus* L., 1758) is a large pelagic fish with a highly migratory behavior and trans-oceanic movement. It is found in the Atlantic Ocean including the Mediterranean Sea and sustains important recreational and commercial fisheries as well as the aquaculture industry [1, 2]. The aim of this study is to estimate the age of fattening bluefin tuna using caudal vertebrae and to determine the length-weight relationship.

Materials and Methods

Fork length (FL) and round weight (RW) measurements were taken from 188 bluefin tuna specimens sampled from the Greek Bluefin Tuna farm, in the Ionian Sea, from December 2007 to January 2008. Length measurements were taken to the nearest centimeter (cm) and weight to the nearest gram (g) and the length- weight relationship was calculated using the equation $RW=a*FL^b$.

A total of 99 caudal vertebrae were used to estimate age by counting the annual growth zones observed on the inner surface of the cones of the whole vertebrae. One ridge and one groove were interpreted as one annulus. Mean lengths at age and the precision of the ageing method were calculated.

Results and Discussion

Fork length and round weight data ranged from 127 to 272 cm and 43 to 475 kg, respectively. The more frequent length classes were between 220 and 240 cm and the more frequent weight classes were between 240 and 270 kg. The slope of the length-weight relationship was bigger than 3 indicating positive allometric growth (Fig. 1). However, the length-weight relationships for the wild individuals present mostly negative allometric growth [2].

Several studies have estimated the age and growth of wild bluefin tuna using calcified structures, but no one has estimated the age of fattening bluefin tuna. The range of the estimated ages was from 5 to 16 years with mean fork lengths 139 cm and 267 cm, respectively (Fig. 2). The age group 10 was dominant. From the samplings we had no young specimens, because at the aquaculture there are only older, from 5 years and over, specimens. A comparison of our results with similar studies revealed that the fattening bluefin tuna present higher mean lengths at age values than these of the wild bluefin tuna [3].

The Average Percent Error (APE), the Coefficient of Variation (CV) and the Index D were 2.21%, 2.89% and 1.67%, respectively. The values of precision estimated keep up with the values of the existing bibliography [3]. The present study revealed the difficulty in distinguishing between the closely spaced increments on the centrum margin of the vertebra that becomes severe at the age of 8 years and onwards. The same difficulty has also been noticed in previous studies [3]. This probably constitutes the major disadvantage of the vertebra method and it is likely to underestimate the age of older fish.

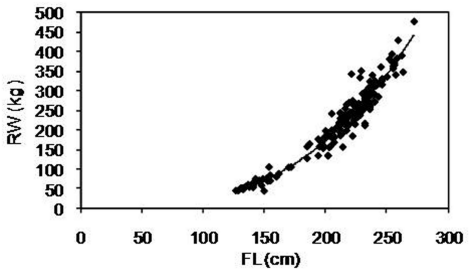


Fig. 1. Fork length-round weight relationship of fattening bluefin tuna, *Thunnus thynnus* ($RW=1.3*10^{-5}*FL^{3.09}$, $R^2=0.96$, n=188)

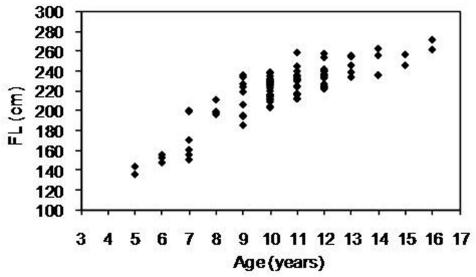


Fig. 2. Fork length versus age estimates from caudal vertebrae band counts of fattening bluefin tuna, *Thunnus thynnus* (n=99)

References

1 - Block B. A., Teo S. L. H., Walli A., Boustany A., Stokesbury M. J.W., Farwell C. J., Weng K. C., Dewar H. and Williams T. D., 2005. Electronic tagging and population structure of Atlantic bluefin tuna. *Nature*, 434: 1121–1127.

2 - Tzoumas A., Ramfos A., De Metrio G., Corriero A., Spinos E., Vavassis C. and Katselis G., 2009. Weight growth of Atlantic Bluefin Tuna (*Thunnus thynnus*, L. 1758) as a result of a 6-7 months fattening process in Central Mediterranean. *ICCAT*, (SCRS/2009/135), Madrid, Spain.

3 - Rodriguez-Marin E., Clear N., Cort J.L., Megalofonou P., Neilson J.D., Neves dos Santos M., Olafsdottir D., Rodriguez-Cabello C., Ruiz M., Valeiras J., 2007. Report Of The 2006 Iccat Workshop For Bluefin Tuna Direct Ageing. *Col. Vol. Sci. Pap. ICCAT*, 60(4): 1349-1392.

PRODUCTION AND COMPOSITION OF SMALL-SCALE FISHERIES LANDINGS IN THE EASTERN AEGEAN SEA

Anastasia Miliou [1]*, Stefan Kolle [1], Joanne Clarke [1] and Monica Demetriou [1]
[1] Archipelagos, Institute of Marine & Environmental Research of the Aegean Sea - a.miliou@archipelago.gr

Abstract
The biomass and species composition of the landings from 7 coastal small scale fisheries vessels were compared over a 5 month period in SW Samos, eastern Aegean Sea. The quantitative composition of the landings was assessed for the different metiers: trammel net, small gillnet, long line, boat seine and a locally practiced metier, “kalami”. The total landing weight of this fleet between June and October was 14.3 tons, dominated by the catches of the small gill net metier (52.7%).
Keywords: Aegean Sea, Eastern Mediterranean, Fisheries, Coastal Management

Introduction
Monitoring of small-scale fisheries can be problematic, due to their wide distribution across the 18,000 km coastline of Greece. Little quantitative information is available on various aspects of Greek small-scale fisheries, and a large part of the catch reaches the local market unreported, especially in non-central regions. However small scale fisheries contribute significantly in terms of weight and value to the total Greek fisheries and are of primary socio-economical importance [1,2]. The species composition of small-scale fisheries have only been studied in a few regions of the Greek seas [1,3,4,5,6,], and have illustrated variation in dominant species caught in the different regions and with different metiers. In this work the quantitative composition of the landings of a small scale fishing fleet in Ormos port, Marathokampos Bay, SW Samos has been examined.

Materials and Methods
The fleet of Ormos port is composed from 7 active small-scale fisheries vessels. This fleet utilizes several metiers, according to the season and the yield of the landings and comprises mainly of trammel nets (mesh size 22-36mm), gill nets (8-9mm), long lines (hook N° 9-14) and boat seines. One boat practiced an unusual local metier named "kalami" (September, October), comprising of an adapted fishing rod targeting *Dentex gibbosus* at 50-150 m depth. The landings of this fleet were recorded on a daily basis from June to October 2009. Recording took place on the port immediately after the arrival of the vessels. The number of individuals and the weight per species were recorded. Information about the used gear, the mesh size or the size of the hooks, the length of the nets or the number of the hooks were collected.

Results and Discussion
The total fishing effort of the fleet during the 5 months of the survey period was 544 days at sea; 56.3% of the time was with trammel nets, 16.5% with 8-9mm gillnets, 14.5% with longline, 7.2% with boat seine and 5.5% with "kalami. The total landings of the trammel net 30-36mm metier were 2039 Kg. The main target species in this metier is *S. scrofa* (20%), *P. elephas* (13%), *P. pagrus* (8%) and *Dentex dentex* (6%). Other fish species accounted for the remainder of 53% of the landed biomass in this metier (Fig.1, A). The 22-24 mm trammel net had total landing weight of 922 Kg, with main target species being *M. surmuletus*, comprising 25.7% of the total landing. The seasonal landings of *Scomber japonicus* and *Coryphaena hippurus* accounted for another 35.9%, whereas other fish species accounted for 38.4% (fig.1, B). The total landing weight in the longlines metier was 1033 Kg, with the main species being *P. pagrus* (32%), *Spondyliosoma cantharus* (26%), *Diplodus vulgaris* (15%) and *D. dentex* (4%) (Fig.1, C). The landings of the boat seine comprised mostly of juvenile fish of various species. The species composition was mainly juvenile *B. boops*, *A. boyeri* and *Sardina pilchardus*, which together accounted for 41.7% of the landed weight (Fig.1, D). The landings from the 'kalami' metier were 474Kg, targeting solely *D. gibbosus*. Further research needs to be carried out to improve the understanding of this locally practiced, high yielding technique. The 8-9 mm gillnet metier accounted for the majority of the total landings (52.7%), by number as well as by weight. This has been reported to be exceptionally high this year yielding a total landing of 7.54 tons from 90 fishing days. The catch was dominated by *B. boops* (84%) and *A. boyeri* (10.2%). Other species such as *Sarpa salpa* and *S. pilchardus* were also present but accounted for <1% of the total landings weight.
The 30-36mm trammel nets target *Scorpaena sp.* and *P. elephas*, but this type of net also caught *P. pagrus*, *Phycis sp.* and *D. dentex*. These are target species of the longline métier, indicating some degree of gear competition. Landings of the 22-24mm trammel net métier show some similarity to the landings reported from the South Euboikos Gulf [4] and the region of Kastellorizo [5] in respect to the common main target species of *M.surmuletus* and *P. arcane*. However, much fewer *M.babartus*, *Spicara maena* and *B.boops* were caught in this métier in Marathokampos Bay. In conclusion, for a greater understanding of the catch composition of small scale fisheries in the Greek seas, further long term research is necessary, covering a wider region and over different seasons. This knowledge is a prerequisite for the development of sustainable fisheries management for multispecies and multi-geared Greek small-scale fisheries.

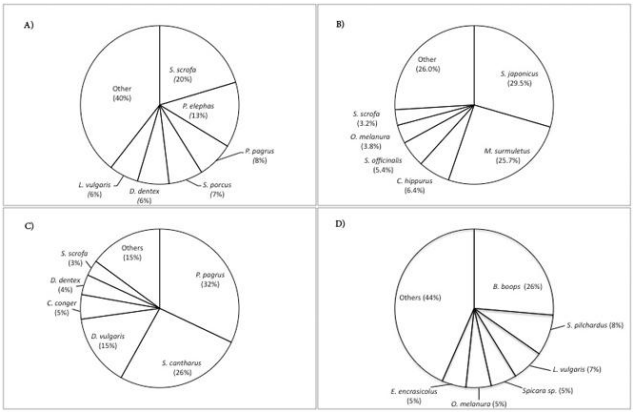


Fig. 1. Catch composition in small scale fisheries metiers in Marathokampos Bay: A) Trammel net, 30-36 mm (06-09/2009), B) Trammel net, 22-24 mm (07-10/2009), C) Long Lines, hook No 9– 14 (08-10/2009) and D) Boat seine (10/2009)

References
1 - Stergiou K I, Christou E D, Georgopoulos D, Zenetos A. & Souvermezoglou C. 1997. The Hellenic Seas: Physics, chemistry, biology and fisheries. *Oceanogr. Mar. Biol. Ann. Rev.* 35: 415 – 538
2 - Koutsikopoulos C. 2002 Development of typology of the Greek professional fishermen of small-scale coastal fisheries, based on fisheries, economical and social characteristics. *Report of the phase A'*. (In Greek). Ichtyka A.E. & University of Patras
3 - Stergiou K I & Erzin K 2002. Comparative fixed gear studies in the Cyclades (Aegean Sea): size selectivity of small-hook long lines and monofilament gill nets. *Fisheries Research 58*: 25-40
4 - Stergiou K I, Petrakis G, Politou C Y. 1996. Small scale fisheries in the South Euboikos Gulf (Greece): species composition and gear competition. *Fisheries Research 26:* 325 – 336
5 - Papaconstantinou C, Caragitsou E, Vasilopoulou V, Petrakis G, Stergiou K. 1988. The coastal fisheries in the Kastellorizo area (Dodecanese). I 15 Athens, 106pp.
6 - Spinos E, Katselis G, Koutsikopoulos K. Seasonal species composition of fisheries caught by trammel net in Kyparissiakos Gulf (Katakolo area) in spring and autumn 1999. (In Greek with English abstract). Proceedings of the 9th Panhellenic Ichthyologist Conference p.77-80

AGE DETERMINATION OF LARVAL AND JUVENILE SMALL PELAGICS: THE IMPORTANCE OF A COMMON PROTOCOL

Beatriz Morales-Nin [1]*, Naroa Aldanondo [2] and Itziar Alvarez [3]
[1] Institut Mediterrani d'Estudis Avançats (CSIC/UIB) - beatriz@imedea.uib-csic.es
[2] AZTI
[3] IMEDEA (CSIC/UIB)

Abstract
The sardine and anchovies' larvae and juveniles age interpretation criterials are defined based on otolith microstructure analysis. Included in SARDONE project, this comparative study was developed in order to understand the life history and recruitment of these key species in the pelagic ecosystem.
Keywords: Fishes, Growth

Introduction
Small pelagic fishes, such as *Sardina pilchardus* and *Engraulis encrasicolus*, are relevant constituents of the Mediterranean pelagic ecosystem. Their populations show evidence of important long-term natural fluctuations in their abundance, related, among other factors, to large-scale climate variability raising important scientific and economic concerns. It is commonly assumed that recruitment variability is largely determined by survival during the larval and juvenile stages. An important tool to decipher the initial life phases relies on them being encoded into otoliths both in the daily growth increments numbers, providing information about the age in days, and in the increment width, which is a proxy of fish growth. However, small pelagic otoliths have complex structures with numerous sub-daily units, that difficult the increment interpretation [1]. Therefore, and as part of SARDONE project (FP6-44294), it was necessary to establish a common age protocol before comparing three Mediterranean area's temporal and spatial patterns in small pelagic larvae and juveniles age and growth. This task was achieved by a step by step process based on the following: a) Interchange of otoliths images for joint otolith interpretation. b) An age interpretation Workshop, which was held in AZTI in 2008 knowledge gaps and which also lead to the establishment of a common protocol. c) A second round interchange of images. d) The 2nd Year meeting was held in the ICM in March 2009. In this meeting it was noted that the ageing was not performed in the same way by all the participants. The main discrepancies were found on the calibration of the images, the identification of the growth patterns and the otolith edge interpretation. e) A second otolith daily increments interpretation workshop, using real otoliths, was considered necessary. It was organized at IMEDEA on May 2009. Based on this iterative method a common criteria was established and applied. AGEING PROTOCOL In order to differentiate daily from sub-daily rings, the methodology suggests bringing the preparation into a focus where all growth structures can be clearly read and then slightly varying the focus, so that the sub-daily increments should disappear. This method could not be applied to the juveniles of small pelagics due to the presence of multiple wide rhythmic growth patterns in the central zone of otoliths (whiter and darker bands) and groups of multiple increments. The method, named Group Band Reading (GBR), consists on counting as one every repetitive cyclic set of growth bands or apparently groups of microincrements (usually 2 but occasionally more), assuming that they are sub-daily marks in postrostral zones corresponding to the early juvenile period [1].The otolith nucleus should be read at 1000 magnification, whilst the rest of the otolith at x100 for anchovy and X200 for sardine. When necessary to assess the growth pattern higher magnification may be used.The grouping of sub increments forming growth bands (GB) is common in all individuals and starts very early in the life history of the fish.The width of the GB is conservative, not sudden changes occurs. In some cases the sub increments are very clear and difficult the identification of the GB. However, once the GB is initiated, this pattern continues. Therefore the group banding interpretation has to be maintained.
Anchovy: The first increment corresponds to the hatch check with a radius between 3.5 and 5 µm [2], the following increments have a width around 1 µm. The GB starts very early in life, with double bands, once formed this pattern has to be kept in all the otolith.

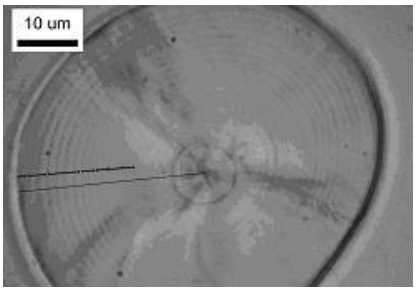


Fig. 1. Anchovy otolith showing the group band pattern age interpretation

Sardine:The hatching check appears at 5-7 µm, the following increments have a width around 1 µm. The GB appears at 40-80 increments after the hatching check, once formed this pattern has to be kept in all the otolith.

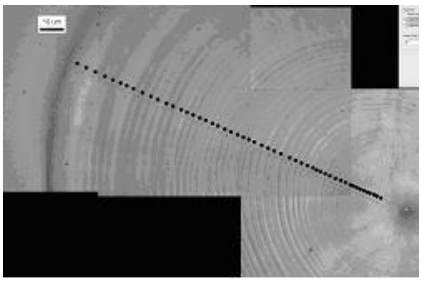


Fig. 2. Sardine juvenile showing the group band pattern age determination

References
1 - Cermeño, P.; Morales-Nin, B.; Uriarte, A., 2006. Juvenile European anchovy otolith microstructure. *Scientia Marina*, 70(3):553-557.
2 - Aldanondo, N; Cotano, U; Etxebeste, E. et al., 2008.Validation of daily increments deposition in the otoliths of European anchovy larvae (*Engraulis encrasicolus* L.) reared under different temperature conditions. *Fisheries Research*, 93: 257-264.

CHANGES ON BIOMASS ESTIMATION AND SPATIAL DISTRIBUTION OF ANCHOVY (ENGRAULIS ENCRAUSICOLUS) IN THE CATALAN PLATFORM

Alicia Mosteiro Cabanelas [1]*
[1] Tecnologías y Servicios Agrarios S.A. - alicia.mosteiro@gmail.com

Abstract
This document provides an insight on the changes detected in the Catalan platform to the anchovy population. Data were collected through two acoustic surveys in 2007 and 2008, providing biomass estimation and spatial distribution as well as some biological information. A significant recovery of the anchovy local population was detected. The length mode has increased from 5.5 cm in 2007 until 9 cm in 2008.
Keywords: Acoustics, Biomass, Ebro Delta, Pelagic

Introduction
An acoustic survey for the follow up of the small pelagic populations in the Catalan platform is carried out annually during December. Up to 10 small pelagic species are assessed during these surveys. The data collected is used as support for management of these species. The situation of anchovy (*Engraulis encrausicolus*) resources in the area was of major concern.

Material and Methods
Acoustic data collection takes place during day hours in December from a vessel platform with a scientific echosounder EK60 mounted on the keel equipped with 3 frequencies (38, 120 and 200 kHz). A pelagic trawl net Gloria352M with 20 m horizontal opening and 10 m vertical opening is used to collect the groundtruth data (biological samples) necessary to identify the schools and determine biological characteristics of the species collected. Transects perpendicular to the coast line are separated 6.5 nm from each other from the Spanish-French border until south of Ebro river delta. Data collection speed is 10 knots and trawling speed is 4 knots. The coefficient for TS calculation was -72.6 for anchovy.

Results and Discussion
Anchovy population has been decreasing in the last years reaching very low levels in 2007. Several management measures like close seasons and minimum landing size have been put in place in order to protect this pelagic stock but they showed no positive results until 2008 when a recovery was detected. The 2007 biomass estimation indicated a stock of 350 tons in the 2000 mn^2 study area with a distribution mainly located in the north of Ebro river delta in front of Tarragona. The individuals collected were very scarce (n=148) and showed a mode in length of 5.5 cm being all immature individuals (size of first maturity is 10 cm).

The length-weight relationship for these samples was as follows:
$W=0.0018*L^{3.6131}$; where $R^2=0.7328$

However, the 2008 biomass estimation showed a recovering situation of the anchovy stock with 8,575.8 tons, twenty times the estimated biomass in 2007. Its spatial distribution was wider indicating that the majority of the population was located in the Gulf of Rosas and the Ebro river estuary (Fig. 1). No samples were found in the rest of the area (approximately 2,000 nm^2).

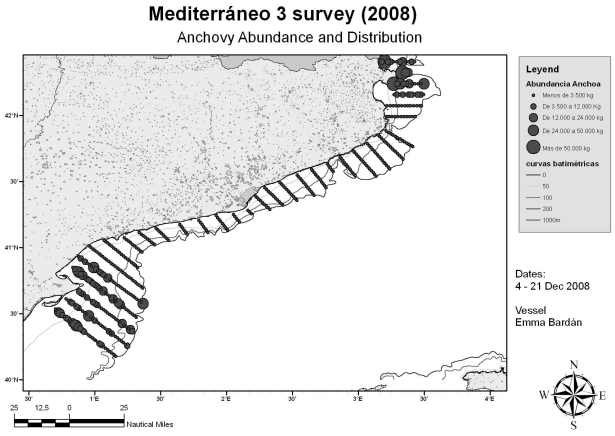


Fig. 1. Spatial distribution and relative abundance of anchovy

Samples were composed by anchovy in 65.7% of weight. The samples collected were more abundant (n=3,264) showing a 9 cm mode in length overall, being 14 cm in the Ebro estuary area, indicating that mature individuals were present in the area in 2008.

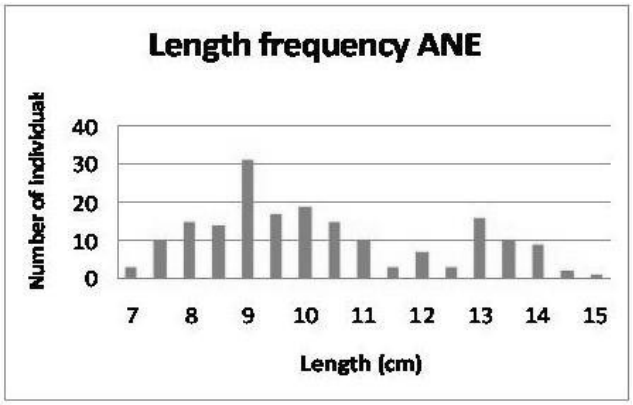


Fig. 2. Anchovy length-frequency for 2008 Gulf of Roses samples

The length-weight relationship for 2008 samples was as follows:
$W=0.0064*L^{2.93}$; where $R^2=0.8988$

The coefficient of determination indicates a positive correlation between length and weight of the specimens. The number of specimens measured and weighed was much larger than in 2007 assuring the representativeness of the samples (Fig. 2).

Conclusions
The anchovy population in the Catalan coast has shown an important recovery from 2007 figures. Mature individuals were found mainly in the Ebro river delta area. The Gulf of Roses has notably increased its anchovy stock.

References
1 - Maclennan, D. N. and Simmonds, E. J., 2005. Fisheries Acoustics. Theory and Practice. Second Edition. Blackwell Science Ltd, 437pp.
2 - Michael King., 1995. Fisheries biology, assessment and management. Fishing News Books. Blackwell Science (ed), pp 117-151.

SPATIAL CONGRUENCE BETWEEN FISH BIODIVERSITY HOTSPOTS, HUMAN IMPACT AND THE NETWORK OF MARINE PROTECTED AREAS AT THE MEDITERRANEAN SCALE

David Mouillot [1]*
[1] Université Montpellier 2 UMR 5119 - david.mouillot@univ-montp2.fr

Abstract
The biodiversity of the Mediterranean Sea is exceptional relative to its water volume. This hotspot of biodiversity and endemism is facing ever increasing human-induced threats and marine protected areas (MPAs) have been extensively established. Rather surprisingly, no attention has been paid to how well the actual network of MPAs spatially matches with the hotspots of biodiversity and how much these hotspots are spatially congruent with human pressures. Here we used spatially explicit data to provide a first global assessment of these congruencies. We show that the global network of Mediterranean MPAs is spatially congruent with fish richness and fish endemic richness hotspots while the highest human pressures spatially matches with hotspots of fish endemic richness but not with hotspots of fish richness.
Keywords: Biodiversity, Conservation, Fishes, Marine Parks

We used the database compiled by Ben Rais Lasram (2009) which includes the geographical distribution areas of all known fish species in the Mediterranean Sea, i.e. 619 species among which 81 are endemic and 120 are exotic. These distributions areas were compiled from the FNAM atlas (Fishes of the Northern Atlantic and Mediterranean) (Whitehead et al. 1986) and digitized using a Geographical Information System software (ArcView3.3 by ESRI). These areas correspond to those of adult stages since they are based on observations and samples and may ignore spawning areas and larvae migration paths.

The digitized polygons were overlaid to a regular grid with a total of 27078 cells covering the whole Mediterranean basin (0.1° latitude x 0.1° longitude). For each cell, species richness was estimated as the sum of the species co-occurring. We excluded exotic species because they are not included in conservation strategies. Migratory, large pelagic species as well as those occurring beyond the continental shelf were also excluded from the analysis because coastal reserves do not provide any benefit for them. Indeed, Mediterranean reserves are often small (e.g. 0.003 km2 for Temuli/Sagone marine cave), and pelagic and migratory species undergo high fishing pressure out of the reserve limits. Species exhibiting a distribution area fraction up to 40% on the continental shelf were considered as coastal and thus included in the analysis. Thus, the final database includes the distribution areas of 345 species.

Even if Marine Protected Areas (MPAs) are not only devoted to fish diversity, since they care much about habitat diversity, recent studies point out their positive effects on fish density and biomass even outside reserve boundaries. Reserves locations were digitized using the Geographical Information System software and compiled from the MedPan data as well as from maps, polygons and GPS coordinates provided by persons in charge of the Mediterranean reserves. Digitizing was carried assuming that even if a small part of a cell belongs to a reserve, the whole species occurring in that cell potentially benefit from the reserve effect. Since the 100 Mediterranean reserves (the Pelagos sanctuary being excluded) are strictly coastal, we only considered the continental shelf because deep-sea ecosystem conservation would require particular strategies. We thus extracted a set of 8186 cells corresponding to the limit of 200m water depth from the 27078 cells constituting the whole Mediterranean Sea dataset.

Each of the 8186 grid cells contained the following information: (i) MPA network with reserve presence (coded 1) or absence (coded 0) (Res), (ii) fish species richness excluding migratory and large pelagic fish and species usually inhabiting beyond the continental shelf (Rich), (iii) endemic fish species richness (End); and (iv) the human-induced pressure values (Press). So, the database consisted of a 8186 rows (grid cells) x four columns (three variables and the reserve network) matrix.

We implemented two different methods that are commonly used to assess spatial congruence: correlations and overlap between hotspots. First, we calculated coefficient of correlations between all pairs of variables. Significance levels were calculated using Dutilleul's degrees of freedom (a correction for spatial autocorrelation), as implemented in the program 'Modttest'. This correction was necessary because spatial autocorrelation in both of the variables under consideration can greatly inflate Type-I statistical error rates. Second, we tested for congruence between the three variables and the reserve network by measuring the extent of spatial overlap between hotspots. To this aim we needed to identify hotspots for human impact and for biodiversity (fish richness and fish endemic richness). Since MPAs are present in 390 cells which roughly represents 5% of the total number of cells on the continental shelf we defined hotspots as the 5% of grid cells with the highest values with respect to species richness, endemism or threat, respectively. When two or several cells had the same number of species they were all included in hotspots. Thus the 5% highest values of each variable were replaced by 1 and other values by 0. So, the new data matrix consisted of 1 and 0 and showed 519, 412, 410 and 390 cell grids with 1 for *Rich*, *End*, *Press* and *Res*, respectively. Then we computed the proportional overlap, as a measure of area shared between two entities expressed as a percentage of the one with the smallest area (number of cells). To this aim, all pairs of columns were considered successively (6 unique combinations) and the observed number of overlaps O_o (i.e. the number of cells for which we had a couple of 1: congruence of hotspots) was counted.

The fish richness pattern exhibits a decreasing gradient from west to east, the Alboran Sea being a hotspot of richness. The endemic species gradient is more pronounced latitudinally, i.e. from north to south: the northern side exhibits a greater richness and the Adriatic appears as a hotspot of endemism with a maximum of 45 species per cell. We observe that fish richness and fish endemic richness hotspots are not congruent at all (0 observed overlap) and significantly less than expected by chance (26.1 cells with overlap). Fish richness and fish endemic richness hotspots are significantly more congruent than expected by chance with the MPA network. Fish richness hotspots are significantly less congruent with human pressure hotspots while fish endemic richness hotspots are significantly more congruent with human pressure hotspots. Finally the MPA network is spatially independent from the hotspots of human pressure. Nevertheless MPAs are not the only tool to sustain fish biodiversity and conservation in the Mediterranean may also deal with fishery management and habitat protection.

References
1 - Lasram F.B.R., Guilhaumon F. & Mouillot D., 2009. Fish diversity patterns in the Mediterranean Sea: Deviations from a mid-domain model. *Marine Ecology Progress Series*. 376: 253–267.

THE MID DOMAIN EFFECT IN THE MEDITERRANEAN SEA: DO GEOMETRIC CONSTRAINTS SHAPE FISH DIVERSITY PATTERNS?

David Mouillot [1]* and Frida Ben Rais Lasram [1]
[1] Université Montpellier 2 UMR 5119 - david.mouillot@univ-montp2.fr

Abstract

We challenged the hypothesis that fish richness gradients are simply artefacts of the bounded nature of the Mediterranean Sea (Mid Domain Effect theory). To this aim, we built a new database on the distribution of the 619 Mediterranean fishes and we implemented one dimensional as well as two dimensional MDE null models to predict fish diversity patterns. Our results revealed that a strong MDE is displayed in 1D and that in 2D, the MDE accounted for a non negligible proportion of species richness variation but is not sufficient to explain the diversity pattern in the Mediterranean Sea.

Keywords: Biodiversity, Fishes

Introduction

The foundations underlying fish diversity patterns in the Mediterranean Sea have been overlooked despite the conservation importance of this biodiversity hotspot. One of the most intriguing theories that have been proposed to explain the spatial distribution of species richness is the Mid Domain Effect (MDE). This theory posits that geometric constraints on species range distributions may create patterns in richness without any environmental gradient. The Mediterranean is an "archetypal situation" where we would expect a MDE, so we tested the predictions of the MDE for fish richness spatial patterns in one (longitude and latitude) and two dimensions.

Material and Methods

We created a database on the geographical distribution areas of all known fish species in the Mediterranean Sea using a Geographical Information System software (ArcView3.3). Data on exotic species were compiled by updating the list of the CIESM Atlas [1] and the list of Quignard and Tomasini [2]. For all other species, data were compiled from the primary literature and particularly from the FNAM atlas [3]. The database was used to map the geographical distribution of fish diversity by overlaying range maps of the 619 species to a 0.1° bin grid for one-dimensional analysis and to a 0.1° cell grid for two-dimensional analysis. Species were also classified according to their range extent into small, intermediate and large ranges [4]. Empirical patterns of species richness in one dimension (longitudinal then latitudinal gradient) were compared to the predictions using two null models: the Colwell's model [5] and the Willig & Lyon's model [6]. We also explored the Mediterranean fish species distribution patterns using the null model of Willig & Lyon extended by Bokma et al. [7] in two dimensions. The relative predictive power of the MDE was assessed by a coefficient of determination (R^2) of the regression between the empirical values of species richness and the predicted values of the models.

Results and Discussion

Longitudinally, fish richness patterns are highly asymmetric for the entire species pool and for the "without exotics" pool, and thus differ markedly from mid-domain predictions. At the opposite, the longitudinal gradient of endemic fish richness appears much closer to MDE predictions (R^2=0.69, $p < 0.001$): endemic species richness (especially large ranged species) exhibits a pronounced mid longitude peak consistent with predictions of a simple 1D MDE model between 13.45° and 15.55° of longitude, which corresponds to the middle of the Mediterranean longitude. Latitudinally, agreement between observed and predicted fish richness gradients was weak for the endemic pool while the agreement was very strong for both the entire species and the "without exotics" pools. When all species were considered together, the explanatory power of MDE on latitudinal fish species richness is strongly significant (R^2=0.63, $p < 0.001$). The highest species richness occurs at about 37.85° to 38.15° of latitude, which corresponds to the middle of the Mediterranean latitude. In two dimensions, R^2 were low except for the large range species. Indeed, the MDE explained 38% (p= 0.001) of variation in fish richness for both the entire and "without exotics" pools and 26% ($p < 0.001$) of variations in fish richness for the endemic pool when considering large range species. For large range species, the highest richness values were found around Sicily, northern Tunisia and Sardinia which is consistent with predictions of the 2D MDE model. Conclusion The Mediterranean Sea can be defined as an archetypical domain where we expect a MDE because this biome is a big domain, is an enclosed area with well defined boundaries, has a high rate of endemic species and has a non negligible proportion of large range species. While a strong MDE is displayed in 1D (both latitudinally and longitudinally), our data on fish species are less consistent with the 2D patterns predicted by the null model: in2D, the MDE accounted for a non negligible proportion of species richness variation but is not sufficient to explain the diversity pattern in the Mediterranean Sea, which corroborates other bi-dimensional studies testing the MDE [8]: other processes such as biological and environmental factors should be considered. However our results suggest that geometric constraints on the locations of large range coastal fish species imply a marked mid-domain peak in species richness, even in the absence of any environmental gradient.

References

1 - Golani D., Orsi Relini L., Massuti E. and Quignard J., 2002. The CIESM Atlas of exotic species in the Mediterranean, Vol 1, Monaco ISBN 92-990003-1-x. 254 pp.

2 - Quignard J.P. and Tomasini J.A., 2000. Mediterranean fish biodiversity. *Biol. Mara. Medit*., 7:66.

3 - Whitehead P.J.P., Bauchot L., Hureau J.C., Nielsen J. and Tortonese E., 1986. Fishes of the north-eastern Atlantic and the Mediterranean, Vol 1,2,3, UNESCO, Paris.

4 - Hawkins B.A. and Diniz Filho J.A.F., 2002. The mid-domain effect cannot explain the diversity gradient of Nearctic birds. *Glob. Ecol. Biog*., 11: 419-426.

5 - Colwell R.K., 2006. RangeModel A Monte Carlo simulation tool for assessing geometric constraints on species richness. In: http://viceroy.eeb.uconn.edu/rangemodel UsGaapa (ed).

6 - Willig M.R. and Lyons S.K., 1998. An analytical model of latitudinal gradients of species richness with an empirical test for marsupials and bats in the New World. *Oikos*, 81: 93-98.

7 - Bokma F., Bokma J. and Monkkonen M., 2001. Random processes and geographic species richness patterns: why so few species in the north? *Ecog*., 24: 43-49.

8 - Rangel T.F.L.V.B. and Diniz Filho J.A.F., 2004. Worldwide patterns in species richness of falconiformes: analytical null models, geometric constraints and the Mid-Domain Effect. Braz. *J. Biol*., 64: 299-308.

SEISMIC EXPLORATION INSIDE THE INTERNATIONAL SANCTUARY FOR THE PROTECTION OF MARINE MAMMALS: RESULTS OF THE MARINE MAMMAL OBSERVERS MONITORING

Aurelie Moulins [1]*, Massimiliano Rosso [1] and Mehdi Aïssi [2]
[1] CIMA Foundation - aurelie.moulins@cimafoundation.org
[2] Dipartimento di Biologia, Università degli Studi di Genova

Abstract
Since 2002, the Pelagos Sanctuary have entered into force, delimiting a large marine area (100,000 km^2) where cetaceans populations are protected. Being in its first stage, Pelagos aims to estimate the human impacts on long-term cetacean conservation. The study presents the results of the April 2008 seismic operations and proposes some recommendations.
Keywords: Seismics, Cetacea, Ligurian Sea

Introduction
Marine anthropogenic noise increases decade by decade with the current uses of sonars and seismic devices. However, effects on the marine ecosystems are not mostly unknown. On cetaceans, the assumed effects are manly distinguished into three categories: (i) effects on the physiology of the animals; (ii) effects on the behaviour of the animal; (iii) indirect effects on prey [1]. All species of the Pelagos Sanctuary can be affected and specifically some had already been involved in mass strandings as Cuvier's beaked whales (*Ziphius cavirostris*), long-finned pilot whales (*Globicephala melas*) or sperm whales (*Physeter catodon*).

Material and methods
The seismic campaign was realized in April 2008 (20-27). The aim was to characterize the seismic activity in the Ligurian basin using ocean-bottom seismometers (OBS) as recorders of air gun shots realized in the study area. The 21 OBS deployed were then left for six months in the area to monitor the seismic activity. Five Marine Mammal Observers (MMO) participated to the campaign in order to detect visually cetaceans. Visual detection was realized using naked-eyes and binoculars. The 360° around the boat were dived into 4 sectors of 90°, each sector was watched by one MMO. The 5th MMO was in charged of the data recording and of communications with the cruise staff for eventual interruptions of the air gun shots. All MMO were positioned at 10 meters above the sea surface and their positions were shifted each 30 min to avoid tiredness. Observation period initiated at 8:30AM and finished at 6:30PM with a 1-hour lunch break for each of the MMO organized into two shifts. Observation was interrupted with bad weather conditions (wind stronger than 15 knots or low visibility). The procedure applied for the campaign was: (1) to start visual detection 30 minutes before any emission of sound; (2) to realize a RAM-UP period of 20 minutes with half of the air guns; (3) then to proceed with all air guns. In the case of cetacean detection inside the 3200 meters around the vessel, sound emissions were automatically interrupted. Once the animal(s) got out of the 3200 meter area, the RAM-UP procedure re-start for 20 minutes then the air guns shots were set as normal capacity.

Results and Discussion
The before exposure period was monitored only during the morning before (4 hours and a half) then the weather got bad (with wind stronger than 15 knots). Three sightings occurred on the continental slope (where water depth is between 1000 and 2000 m): 3 groups of striped dolphins. The last group was the larger group with about 40 dolphins. No other species has been observed during the morning. On April, the 21st, after 30 minutes of no cetacean detection, the RAM-UP period started at 9:17AM, then "full" air gun shots started at 9:37AM and emission went on until the 27th in the early morning. During the 6 days of sound emission, the vessel covered 1308 km: 563 km during the night (43 %). Considering the working period of the 5 MMO (limited to 8:30AM-6:30PM), 56 % of the sound emission period were not monitored including the 175 km realized during the early morning or during the late evening. On the total period of sound emission, 27 % were realized with bad weather conditions (that did not allow cetacean detection); however, a part of those occurred during the night period. On 7 occasions, cetacean were detected. In all cases, they were striped dolphins. Only in two cases, dolphins were inside the 2000 meter area, therefore sound emission have been interrupted until the animals got away. Both times, no direct modification of the behaviour have been registered before and after the interruption (looking at group head or breaching behaviour). Nevertheless, the direct influence of sounds is hard to determine. The after-exposure period was monitored for 7.5 hours on the track to the home port. Eight sightings occurred inside the study area (where air gun shots have been performed before). The sighted species were: fin whales (3 times), sperm whale (1) and striped dolphins (4). No unusual behaviour have been sighted.

Data from the French stranding network registered before, during and after the seismic exploration did not indicate particular increase of strandings (personal communication from F. Dhermain).

In conclusion, the seismic campaign was realized during April, month of spring period in which the Ligurian sea gets usually rich in biodiversity. Considering the high presence of cetaceans in the Pelagos area especially at this moment of the year, MMO were necessary. Results of this campaign could be use for further recommendations: (1) to ensure success of visual detection (and avoid of tiredness) during the 14 hours of daytime period, it is necessary to organize shifts with sufficient number of MMO; (2) pre-exposure and post-exposure periods (being fundamental to determine the effects of sound emissions) should be extend to more than one day (to maximize the potential of monitoring); (3) the RAM-UP period seems to allow cetaceans to get out of the risky area without having physiological damages; (4) the choice of emission survey period should depend on the seasonal use of cetaceans, especially in the Pelagos Sanctuary; (5) the survey organization should take into account of the use of the study area by the species; for instance covering areas with higher risk during the daytime.

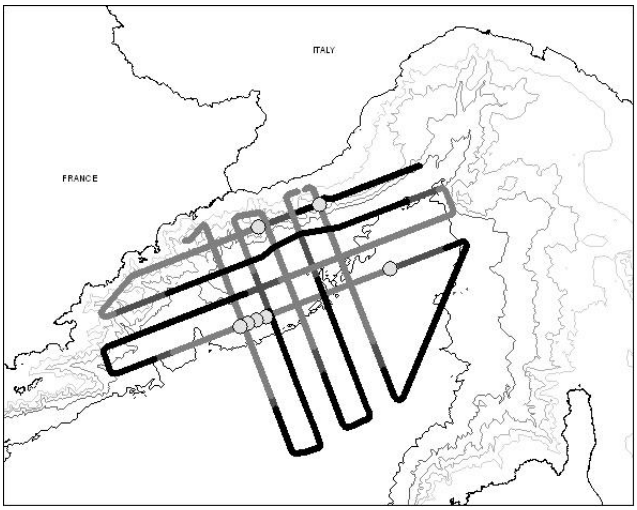


Fig. 1. Sound emission track during the MMO monitoring (light grey), during the daytime without MMO (dark grey) and during the night (black); dots: positions of striped dolphin sightings; depths: 500m, 1000m, 1500m, 2000m and 2500m.

Acnowledgements : We thanks *Geoazur* for the logistic support and all the GROSMARIN team on board.

References
1 - Gordon J., Gillespie D., Potter J., Frantzis A., Simmonds M.P., Swift R.J. and Thompson D., 2004. A review of the effects of seismic surveys on marine mammals. *Mar. Tech. Soc. J.*, 37(4): 16-34.

EGG PRODUCTION, FEEDING AND METABOLISM OF *CLAUSOCALANUS FURCATUS* IN A MEDITERRANEAN COASTAL AREA (SARONIKOS GULF, AEGEAN SEA, GREECE)

A. Moutsopoulos [1]*, E. Christou [1], S. Zervoudaki [1], C. Frangoulis [1], A. Pavlidou [1], I. Siokou [1] and T. Zoulias [1]
[1] Hellenic Centre for Marine Research - thanmoutsop@ath.hcmr.gr

Abstract
Egg production, feeding and metabolism experiments of the calanoid copepod *Clausocalanus furcatus* were studied from July until October 2009 in an eastern Mediterranean coastal area. Egg production rate ranged from 8,28 to 20,65 eggs/fem/day. Ingestion rate ranged from 0,0013 to 0,0208 μg chl-α/fem/day. The range of respiration rate was 0,0614 - 0,0958 μl O_2/ind/hour, while those of phosphate-P and ammonium-N excretion rates were 0,0001 - 0,0002 μg P/ind/hour and 0,0010 - 0,0034 μg N/ind/hour respectively. Egg production was not related with chl-α whereas ingestion was in agreement with egg production. In general ingestion followed chl-α variability.
Keywords: Aegean Sea, Copepoda, Eastern Mediterranean, Zooplankton

Introduction
Clausocalanus furcatus is a widespread species inhabiting epipelagic waters in subtropical and tropical areas [4]. In Mediterranean it attains high numbers during warm season [8]. Most studies concerning this copepod deal with spatial and temporal distribution whereas little is known about its biology ([1], [2], [3], [5], [6], [7], [9], [10]). The present study provides data on feeding activity, egg production and metabolism of this copepod in a coastal area of the eastern Mediterranean during summer and autumn 2009.

Materials & Methods
Adult females were incubated in seawater collected from the sampling area. A total of 20 experiments (9 for egg production, 7 for feeding and 4 for metabolism) were performed biweekly from July 2009 until October 2009. Experimental bottles were incubated in a temperature-control room at *in situ* temperature with photoperiod (egg production, feeding) or in the dark (metabolism) for 24 hours.

Results & Discussion
Temperature ranged from 26,5 °C to 22,7 °C showing a constant decline during the study period. Chl-α (from the initial bottles of the feeding experiments) ranged from 0,071 to 0,336 μg chl-α/lt. Egg production rate (EPR) ranged from 8,28 to 20,65 eggs/fem/day and Ingestion rate (IR) ranged from 0,0013 to 0,0208 μg chl-α/ind/day (Fig. 1). Ranges of metabolic rates were 0,0614-0,0958 μl O_2/ind/hour for respiration, 0,0001 - 0,0002 μg P/ind/hour for phosphate-P excretion and 0,0010 - 0,0034 μg N/ind/hour for ammonia-N excretion (Fig 2). Egg production was not related with chl-α whereas it was in agreement with ingestion. Ingestion appears to follow the pattern of chl-α. Concerning metabolism, the maximum of respiration and the minimum of excretion (for both phosphate and ammonium) are all recorded at the end of the study period.

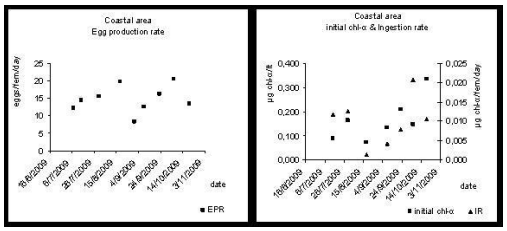


Fig. 1. Egg production rate, initial chl-α and ingestion rate

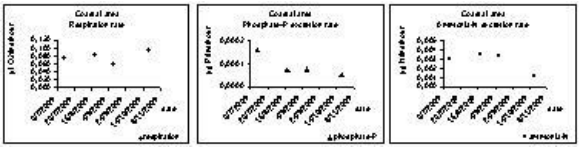


Fig. 2. Respiration rate, Phosphate-P and Ammonium-N excretion rate

Acknowledgements : The present work has been supported by a PhD fellowship from S.E.S.A.M.E. integrated project (supported by the European Commission)

References
1 - Bi H, Benfield MC., 2006. Egg production rates and stage-specific development times of *Clausocalanus furcatus* (Copepoda, Calanoida) in the northern Gulf of Mexico, *J Plankton Res* 28(12): 1199-1216.
2 - Cornils A, Niehoff B, Richter C, Al-Najjar T, Schnack-Schiek SB., 2007. Seasonal abundance and reproduction of clausocalanid copepods in the northern Gulf of Aqaba (Red Sea). *J Plankton Res* 29(1): 57–70.
3 - Cornils A, Schnack-Schiel SB, Böer M, Graeve M, Struck U, Al-Najjar T, Richter C., 2007. Feeding of Clausocalanids (Calanoida, Copepoda) on naturally occurring particles in the northern Gulf of Aqaba (Red Sea). *Mar Biol* 151:1261–1274.
4 - Frost B.W., Fleminger A., 1968. A revision of the genus Clausocalanus (Copepoda: Calanoida) with remarks on distributional patterns in diagnostic characters. *Bull. of the Scripps Instit. of Oceanography*, 12, 1-235.
5 - Mazzocchi M.G., Paffenhöfer GA., 1998. First observations on the biology of *Clausocalanus furcatus* (Copepoda, Calanoida). *J Plankton Res*, 20, 331–342.
6 - Mazzocchi MG, Paffenhöfer GA., 1999. Swimming and feeding behavior of the planktonic copepod *Clausocalanus furcatus*. *J Plankton Res* 21:1501–1518.
7 - Paffenhöfer GA., 2006. Oxygen consumption in relation to motion of marine planktonic copepods. *Mar Ecol Prog Ser* 317: 187–192.
8 - Siokou-Frangou I, Christou ED, Fragopoulu N, Mazzocchi MG., 1997. Mesozooplankton distribution from Sicily to Cyprus (Eastern Mediterranean):II. Copepod assemblanges. *Oceanol Acta* 20(3):537-548.
9 - Wiggert JD, Haskell AGE, Paffenhöfer GA, Hofmann EE, Klinck JM., 2005. The role of feeding behavior in sustaining copepod populations in the tropical ocean. *J Plankton Res* 27(10): 1013–1031.
10 - Zervoudaki S, Christou ED, Nielsen TG, Siokou-Frangou I, Assimakopoulou G, Giannakourou A, Maar M, Pagou K, Krasakopoulou E, Christaki U, Moraitou-Apostolopoulou M., 2007. The importance of small-sized copepods in a frontal area of the Aegean Sea. *J Plankton Res* 29(4): 317–338.

RELATIONSHIPS BETWEEN OCTOPUS VULGARIS LANDINGS AND ENVIRONMENTAL FACTORS IN THE NORTHERN ALBORAN SEA: AN ATTEMPT TO DEVELOP A PREDICTIVE MODEL

F. Moya [1]*, M. Vargas-Yáñez [1], M. González [1], M. García-Martínez [1], P. Zunino [1] and J. Rey [1]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Málaga - francina.moya@ma.ieo.es

Abstract
The stock abundance of short life-cycle species is very sensitive to the strength of annual recruitment, and the latter is influenced by environmental factors [1]. One of the aims of the present work is to accurately delimit the spawning period of *O. vulgaris* in the northern Alboran Sea, using maturity data, and the fishing season (from landing data). Finally we develop a predictive model which relates landings during the fishing season to environmental variables some months on advance. We show that environmental monitoring programs provide information that is extremely valuable to understand the factors that affect the abundance variability of this species, as well as for predicting and managing this resource
Keywords: Alboran Sea, Cephalopods, Models, Monitoring, Time Series

Introduction
Numerous environmental variables influence recruitment strength and stock abundances of fish species [1], [2]. This fact is more important in short life-cycle species because the stock abundance is very sensitive to the strength of annual recruitment. *O.vulgaris* is especially susceptible because annual recruitment is responsible for the entire stock biomass. In this work we have obtained environmental variables-abundance relationships in order to develop a predictive model for the northern Alboran Sea (fig. 1).
Maturity data have been used to delimit the spawning season, helping to choose the months when environmental variables should be used as predictors of the fishing season landings. Finally, the environmental factors-landings relationships found are used for developing a predictive model.

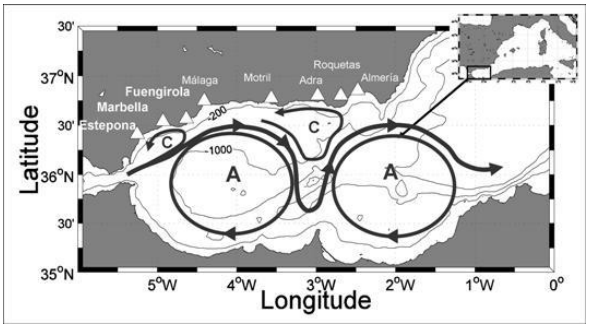


Fig. 1. Alboran Sea

Material and Methods
Monthly octopus landings from 1987 to 2008 in the northern Alboran Sea were used. Monthly environmental data were collected for the same period from ICOADS, NOAA, the Mediterranen Group on Climate Change from Instituto Español de Oceanografía (www.ma.ieo.es/gcc), from the project RADMED ("Series Temporales de datos Oceanográficos") funded by IEO, and also from the NCEP. Octopus landings and environmental variables time series were de-trended. Resultant time series were tested for normality and Pearson correlation coefficients between landing anomalies and environmental variables were calculated. Selected variables were used in a stepwise linear regression in order to select a set of candidate models. Akaike Information Criterion AICc and Cross Validation tests were used to select the best model.

Results and Discussion
The best predictive model was a linear combination of the mean Alboran Sea SST and the local temperature in Fuengirola beach. Our results show that an increase of octopus landings is related with negative temperature anomalies. Using the model, we have predicted octopus landings one year ahead (fig. 2) using natural years for defining the predictors and the landings. In the future, octopus maturity data will allow us to define accurately the spawning season and then select the months in which environmental factors will be considered. In this way, we would construct a model that would be more adjusted to the reality. This work has demonstrated that environmental monitoring an extremely valuable tool for the management of this resource.

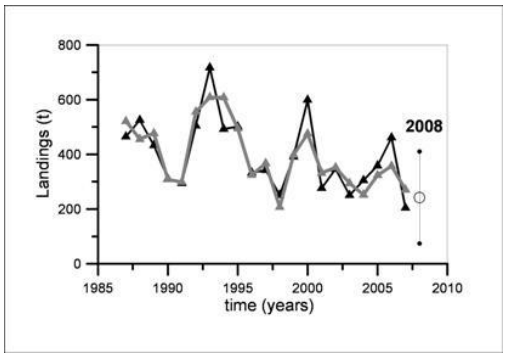


Fig. 2. Dark line: annual octopus landings. Grey line: landings predictive by a linear model

References
1 - Caddy, J.F., 1983 The Cephalopods: factors relevant to their population dynamics and to the assessment and management of stocks. *In*: Caddy, F.J. (Ed), Advances in assessment of world cephalopod resources. FAO Fisheries technical papers, pp. 416-449.
2 - Vargas-Yáñez, M., Moya, F., García-Martínez, M.C., Rey, J., González, M., Zunino, P., 2009. Relationships between *Octopus vulgaris* landings and environmental factors in the northern Alboran Sea (Southwestern Mediterranean). *Fisheries Research*, 99: 159-167.

PRELIMINARY DATA ON THE TROPHIC INTERACTIONS BETWEEN *SCYLIORHINUS CANICULA* (SCYLIORHINIDAE) AND *RAJA CLAVATA* (RAJIDAE) IN THE CENTRAL-WESTERN MEDITERRANEAN

Antonello Mulas [1], Andrea Bellodi [1], Antonio angelo Pendugiu [1] and Serenella Cabiddu [1]*
[1] Department of Animal Biology and Ecology, University of Cagliari, Italy - cabiddus@unica.it

Abstract
Preliminary data on the diet and trophic competition between *Scyliorhinus canicula* and *Raja clavata*, caught in the seas surrounding Sardinia (central-western Mediterranean),during trawl surveys carried out from 2005 to 2008 are given. The low values of Levin and Shannon-Weaver indexes showed that these two species are specialized predators. The ontogenetic analysis of the diet showed different predatory patterns.
Keywords: Diet, Western Mediterranean, Biodiversity, Competition

Introduction
The Scyliorhinidae *Scyliorhinus canicula* L., 1758 and the Rajidae *Raja clavata* L., 1758 are certainly included among the most common selachian species caught by trawl in the italian seas [1]. Despite this relative abundance, not much is known about the trophic interactions between these two species occupying the same depth ranges. The aim of this work is to add further data on this item through the analysis of the levels of trophic competition between the two selachians.

Materials and Methods
A total of 541 specimens (299 of *R. cavata* and 242 of *S. canicula* respectively) were caught at depths between 40 and 660 m, during trawl surveys carried out from 2005 to 2008 in the seas surrounding Sardinia (central-western Mediterranean). In order to examine the diet of each species, %Cn, %F, %W and %I.R.I. were calculated. The diet breadth was studied through the indexes of Levin (Bi) [2] and Shannon–Weaver (H') [3]; Morisita's simplified index (C) [2] and multidimensional scaling (MDS) [4] were also used in order to determine the intra and interspecific competition. The prey categories responsible for the groupings derived from the MDS were identified by SIMPER test [5]. The ontogenetic variation of the diet was also performed on three size classes (small, medium and large).

Results and Discussion
Despite the high variety of preys, the low values of Bi and H' (Bi = 0.46 and H' = 2.27 for *S. canicula*, and Bi = 0.44 and H' = 2.20, for *R. clavata*), showed a stenophagous alimentary behaviour. In *S. canicula* 44 prey categories, assembled in 7 main groups (Crustacea, Osteichthyes, Cephalopoda, Polychaeta, Cnidaria, Tunicata, Echinodermata) were found. Crustacea (%Cn = 67, %I.R.I. = 77.9), and particularly Decapoda (%Cn = 34, %I.R.I. = 70), Mysidacea (%Cn = 26, %I.R.I. = 13) and Euphausiacea (%Cn = 28, %I.R.I. = 14) dominated the diet, while Osteichthyes and Cephalopoda were the most important secondary preys. A total of 95 prey categories were identified in the stomachs of *R. clavata*, grouped into 10 main groups (Crustacea, Osteichthyes, Chondrichthyes, Cephalopoda, Gastropoda, Foraminifera, Polychaeta, Cnidaria, Tunicata, Echinodermata). Crustacea (% Cn = 77, %I.R.I. = 69), and particularly Decapoda (%Cn = 28, %I.R.I. = 73) and Mysidacea (%Cn = 32, %I.R.I. = 16), represented the most predated items. Osteichthyes were secondary preys. In both species the diet is influenced by size. Diet of juvenile *R. clavata* was centred on small Crustacea (mainly Mysidacea, Decapoda and Amphipoda), substituted by Osteichthyes (principally *Glossanodon leioglossus*) and larger Decapoda (*Solenocera membranacea*) in the medium and large size classes. In *S. canicula*, the stenophagy decreased during the ontogenetic development. Smaller individuals feed mainly on Euphausiacea, while Decapoda increased in importance during the growth. Morisita's index showed relatively high levels of intraspecific competition in all the *S. canicula* size groups (C= 0.78, 0.61 and 0.86 among SC1-SC2 SC1-SC3 and SC2-SC3 respectively) and only among medium and large specimens in *R. clavata* (C= 0.89); interspecific competition was relevant only among juveniles *R. clavata* and the first two *S. canicula* groups (C values near 0.70), due to the consumption of Crustacea, and among medium *R. clavata* and large *S. canicula* (C = 0.75), due to Crustacea and Osteichthyes. These results were confirmed by the MDS analysis, with the only exception of small *S. canicula* which formed an isolated group, due to the high presence of Euphausiacea in their diet (SIMPER test). Despite of the same depth range occupied, the two species showed different alimentary patterns. Considering their K type life strategies, these particular predatory behavior should probably be adopted in order to minimize trophic competition, facilitating the species' survival. Further studies will be useful to clarify these statements.

References
1 - Relini G., Biagi F., Serena F., Belluscio A., Spedicato M.T., Rinelli P., Follesa M.C., Piccinetti C., Ungaro N., Sion L. and Levi D., 2000. I selaci pescati con lo strascico nei mari italiani. *Biol. Mar. Medit.*, 7(1): 347–384.
2 - Krebs C.J., 1989. Ecological methodology. Harper & Row Publishers, New York, 654 p.
3 - Shannon C. and Weaver W., 1949. The Mathematical Theory of Communication. University of Illinois Press, Urbana. 117 pp.
4 - Kruskal J.B., 1964. Nonmetric multidimensional scaling: a numerical method, *Psychometrika*, 29: 115-129.
5 - Clarke K.R. and Gorley R.N., 2006. PRIMER v6: User manual/tutorial, PRIMER-E, Plymouth UK, 192 pp.

INVESTIGATION ON THE FEEDING HABITS OF EUROPEAN HAKE *MERLUCCIUS MERLUCCIUS* (LINNAEUS, 1758) IN THE NORTH MARMARA SEA

Elif Murat Dalkara [1]* and Ahsen Yuksek [1]
[1] Istanbul University, Institute of Marine Sciences and Management - elfmurat@yahoo.com

Abstract
This study was performed between April 2008 and August 2009 to determine the feeding habits of European hake (*Merluccius merluccius*). The specimens were collected from the range of 20-90 meters depth by trawl net from the North Marmara Sea. During the research period, a total of 343 specimens were examined and the main diet of European Hake, based on prey index of relative importance, comprised Teleostei (91,2%), Crustacea (5,1%) and Echinoidea (3,6%).
Keywords: Fishes, Diet, Marmara Sea, Fish Behaviour

Introduction
European hake (*Merluccius merluccius*) is an important predator of Marmara communities. Hake's ecological and economic importance are related to many aspects of its biology [1]. Dietary studies are crucial for their contribution to a better understanding of the trophic levels and food webs [2]. The purpose of this study was to examine to feeding habits of European hake caught in north of the Marmara Sea with based on the seasonal analysis of its stomach contents.

Materials and Methods
Specimens were collected from April 2008 to August 2009 from the range of 20-90m depth in all seasons from the Sea of Marmara by using a bottom trawl (Fig. 1). A total of 343 hakes were dissected on board immediately after capture. Stomachs preserved in 4% formalin for further analysis. Prey items were identified and sorted into taxonomic groups at the level of species in the laboratory. Remains of the preys that contained otoliths of various fishes were identified by the help of published guides. Each prey was weighted to the nearest 0,01g. After analysis, percentage frequency of occurence (F%), percentage by numbers (N%), percentage by weight (W%), the index of relative importance (IRI) and percent of IRI (IRI%) were calculated [3, 4].

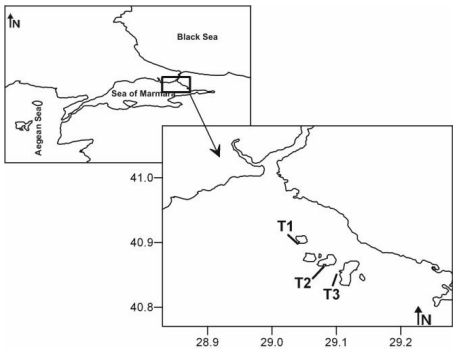


Fig. 1. Location of sampling areas in the Marmara Sea

Results and Discussion
During the research period, a total 343 *M. merluccius* were examined. 134 stomachs of specimens were determined to be empty and 209 stomachs of them were determined to be full. As families or species 20 different prey groups were identified from the stomach contents, Teleostei represented 91,2% the index of relative importance (IRI%), Crustacea 5,2% and Echinoidea 3,6%. During all seasons except summer, the main food group (diet) of hake, based on weight was Teleostei, (Table 1). Crustacea, especially shrimps, were the most represented prey group in summer with 55,8% of IRI. The most important Teleostei species was *Trachurus mediterraneus* in the diet. Echinoidea seemed to be an important prey group in the diet of juveniles, this situation can be related to the way of foraging of juveniles.

Tab. 1. Feeding composition of European hake in north of the Marmara Sea for all seasons.

	Spring (n=63)				Summer (n=68)			
Prey	F%	N%	W%	IRI%	F%	N%	W%	IRI%
Polychaeta	4,44	3,39	0,01	0,28	-	-	-	-
Crustacea	11,11	11,86	0,11	1,05	40,82	40,74	53,35	55,58
Cnidaria	-	-	-	-	-	-	-	-
Echinodermata	-	-	-	-	14,29	12,96	0,4	2,76
Spinculida	2,22	3,39	<0,01	0,14	-	-	-	-
Mollusca	2,22	1,69	0,05	0,07	-	-	-	-
Tunicata	-	-	-	-	-	-	-	-
Teleostei	97,78	79,66	99,84	98,47	44,9	46,3	46,25	41,66
	Autumn (n=138)				**Winter (n=74)**			
Prey	F%	N%	W%	IRI%	F%	N%	W%	IRI%
Polychaeta	-	-	-	-	-	-	-	-
Crustacea	20,29	20	8,23	3,41	12,24	9,84	0,43	1,01
Cnidaria	1,45	1,18	0,99	0,06	-	-	-	-
Echinodermata	17,39	14,12	0,03	4,36	22,45	18,03	0,04	6,59
Spinculida	-	-	-	-	-	-	-	-
Mollusca	-	-	-	-	-	-	-	-
Tunicata	2,9	2,35	0,41	0,07	-	-	-	-
Teleostei	75,36	61,18	90,33	92,08	89,8	72,13	99,53	92,4

References
1 - Carpentieri, P. and Collaca, F., 2005. Feeding habits of European hake (*Merluccius merluccius*) in the Central Mediterranean Sea. Fish. Bull., 103(2): 411-416.
2 - Bozzano, A., Recasens, L. and Sartor, P., 1997. Diet of the european hake Merluccius merluccius (Pisces: Merluciidae) in the Western Mediterranean (Gulf of Lions). Sci. Mar., 61(1): 1-8.
3 - Pincas , L.M., Oliphant, S. and Iverson, I.L.K, 1971. Food habits of albacore, bluefin tuna and bonito in Californian waters. Calif. Fish game ,Fish, Bull., 152, 1-105.
4 - Bowen S.H., 1996. Quantitative desciription of the diet. In: (Murphy B.R. and Willis D.W., eds), Fisheries techniques. American Fisheries Society, Maryland, 513-532.

FEEDING HABITS OF *CEPOLA MACROPHTHALMA* (PISCES: CEPOLIDAE) IN IZMIR BAY, AEGEAN SEA

Tuncay Murat sever [1], Bahar Bayhan [1]* and Semih Leblebici [1]

[1] Ege University, Faculty of Fisheries, Department of Hydrobiology, 35100 Bornova-Izmir, Turkey - bahar.bayhan@ege.edu.tr

Abstract

Stomach contents of 180 *Cepola macrophthalma* (Linnaeus, 1758) specimens collected from Izmir Bay, Aegean Sea (Turkey) have been analyzed. A total of 17 different species of prey was found belonging to nine major systematic groups, i.e. Polychaeta, Crustacea, Mollusca, Chaetognatha, Thaliacea, Appendicularia, Medusae, Siphonophora and Teleostei. Crustaceans (especially copepoda and decapoda) were the most important prey in terms of IRI% in overall diet composition. However, fish larger than 19.9 cm feeding on teleost larvae.

Keywords: Diet, Fishes, Aegean Sea

Introduction

The red bandfish is a demersal species inhabiting soft and muddy bottoms at depths ranging mainly from 15 to 200 m. It occurs in both temperate and subtropical waters and is known to be distributed in the eastern Atlantic from the British Isles to the north of Senegal [1, 2]. It is also common throughout the Mediterranean, as well as in Turkish seas, but not in the Black Sea [1, 3]. The red bandfish has economical importance in Spain and Italy [2, 4], but has no commercial value in Turkey [5]. Biological aspects of the red bandfish have been studied by several authors [2, 4, 6, 7, 8], especially in its westwards distribution in the Mediterranean. However, published data on its diet composition in Turkish seas is not currently available, except the data on its age and growth parameters [5].

The purpose of the present study is to improve knowledge on the feeding habits of red bandfish on the Izmir Bay (Aegean Sea coast of Turkey).

Material and Methods

Specimens were collected by trawl in the Izmir Bay, Turkish Aegean Sea from May 2005 to June 2006. A total of 180 *C. macrophthalma* stomach contents was examined for 45 number every season. Quantitative description of the diet was given as [9]. Besides, IRI% was estimated in order to determine ratios of food groups in the stomach to overall food groups.

Results and Discussion

The overall diet composition revealed that the chub mackerel fed mainly on copepods during all seasons (Table 1). Only in summer decapods were the second main important prey. However, fish larger than 19.9 cm feeding on teleost larvae (Fig. 1). An examination of the previous literature has shown that, *C. macrophthalma* is an planktivorous fish species with diet varying according to specimen size, locality, season etc. [6, 7].

Tab. 1. Feedings habits of *Cepola macrophthalma* from the Izmir Bay during all seasons (%IRI: percentage index of relative importance)

Prey groups	Spring	Summer	Autumn	Winter
Polychaeta	0.54	0.03	-	-
Crustacea				
Ostrocoda	0.10	0.06	0.11	0.11
Copepoda	86.79	79.98	88.89	87.32
Cladocera	3.78	1.91	1.30	0.37
Mysidacea	0.53	0.05	0.07	0.10
Cirripedia	0.03	0.91	3.22	0.02
Isopoda	0.16	0.16	-	-
Amphipoda	0.07	-	0.08	0.05
Brachyura	0.05	1.13	0.18	0.92
Decapoda	1.13	15.49	2.87	8.50
Mollusca				
Gastropoda	0.02	-	-	-
Bivalvia		-	1.54	0.09
Chaetognatha	0.11	-	0.83	0.67
Thaliacea	0.95	-	-	-
Appendicularia	2.73	-	0.37	1.82
Medusae	2.16	-	-	-
Siphonophora	0.32	-	-	-
Teleostei	0.69	0.27	0.53	0.04

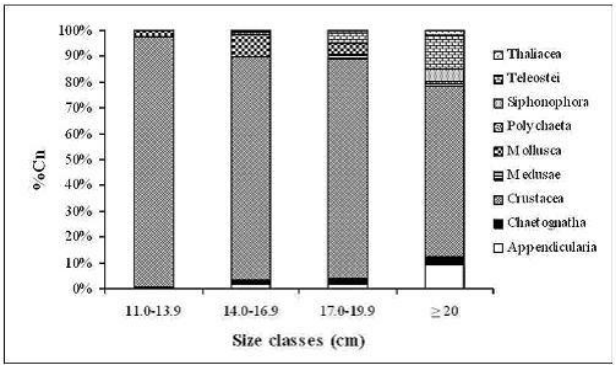


Fig. 1. Percentage numerical abundance (%Cn) distributions of main food groups in the diet of *Cepola macrophthalma* by size groups

References

1 - Tortonese, E., 1986. Cepolidae. In : *Fishes of the North-eastern Atlantic and the Mediterranean*, Vol II. Whitehead, P.J.P., Bauchot, M.L., Huraeu, J.C., Nielsen, J., Tortonese, E. (eds.). UNESCO, pp. 810-811.

2 - Stergiou, K.I., Economidis, P. and Sinis, A., 1992. Age, growth and mortality of red bandfish, *Cepola macrophthalma* (L.), in the western Aegean Sea (Greece). *Journal of Fish Biology*, 40: 395-418.

3 - Bilecenoglu, M., Taskavak, E., Mater S., Kaya, M., 2002. Checklist of the marine fishes of Turkey, *Zootaxa*, 113: 1-194.

4 - Stergiou, K.I., Economidis, P. and Sinis, A., 1996. Sex ratio, spawning season, and size at maturity of red bandfish in the western Aegean Sea. *Journal of Fish Biology*, 49: 561-572.

5 - Kaya, M., Ozaydin, O. And Benli, H.A., 2001. Age and Growth Parameters of Red Bandfish (Cepola rubescens L., 1766) in Izmir Bay. *Turk J Zool.*, 25: 111-116.

6 - Atkinson, R.J.A., 1976. Some preliminary field observations of the burrows of the red bandfish, *Cepola rubescens*. *Journal of Fish Biology*, 9: 181-183.

7 - Stergiou, K.I., 1993a. Nutrient-dependent variation in growth and longevity of the red bandfish, *Cepola macrophthalma* (L) in the Aegean Sea. *Journal of Fish Biology*, 42: 633-644.

8 - Stergiou, K.I., 1993b. Abundance-depth relationship, condition factor and adaptive value of zooplanktophagy for red bandfish, *Cepola macrophthalma* (L.) in the Aegean Sea. *Journal of Fish Biology*, 42: 645-660.

9 - Hyslop, E.J., 1980. Stomach contents analysis. A review of methods and their application. *Journal of Fish Biology*, 17: 411-429.

THE SPATIAL ZOOPLANKTON DISTRIBUTION IN THE NORTH – WESTERN BLACK SEA REGION: SPRING AND AUTUMN, 2008

Mihaela Muresan [1]* and Teodora Maria Onciu [2]
[1] National Institute of Marine Geology and Geoecology – GeoEcoMar, Constanta Branch - mmuresan@geoecomar.ro
[2] Ovidius University Constanta

Abstract
The seasonal distribution of zooplankton community in the NW part of Black Sea have been assessed regarding on the variability of numerical abundance and biomasses as well as the vertical patterns of distribution in the water column. The results are based on 66 quantitative samples collected within SESAME international projects carried out in 2008. 28 taxa belonging to 13 systematic groups have been found. The greatest number of species had Crustacea Class while *Noctiluca scintillans* was remarked for its density.
Keywords: Zooplankton , Vertical Profile, Black Sea

Introduction
Climate change affects in many ways the response of marine ecosystem biota. Temperate marine environments may be particularly vulnerable to these changes because the recruitment success of higher trophic levels is highly dependent on synchronization with pulsed planktonic production [1]. SESAME aims was to assess and predict changes in the Mediterranean and Black Sea ecosystems as well as changes in the ability of these ecosystems to provide goods and services.

Materials and methods
During April and September 2008, have been collected 66 quantitative samples of zooplankton in 9 stations in the NW part of Black Sea (between $44^0 46^{'}$ N and $42^0 29^{'}$ N latitude and 28°64'E and 30°59'E longitude). The sampling was performed using a Hensen zooplankton net with mouth area 0.384 m^2, and mesh size 125μm. The vertical profile included 6 or fewer intervals of depths (0-10, 10-25, 25-50, 50-100, 100-150, 150-200 m) between isobaths of 15 m inshore to 2000 m outshore. Sampling volume was estimated by multiplying the mouth area with the wire length.

Results and Discussion
There where identified 24 taxa: 1 Dinophyceae, 2 Rotifera, 3 Ctenophora, 4 Branchiopoda (Cladocera), 8 Crustacea (Cirripedia –1, Calanida – 6, Cyclopida – 1), Chaetognata – 1, Tunicata – 1 and meroplanktonic larvae (Polychaeta, Gastropoda, Bivalvia, Decapoda). Their populations have registered an average density of 703.15 $ind.m^{-3}$ and an average biomass of 52.34 $mg.m^{-3}$ The numerical structure of zooplankton communities was composed by 63% Crustacea (34% Calanida, 27% Cladocera), 18% Dinophyceae, 12% Rotifera, 2% Tunicata.

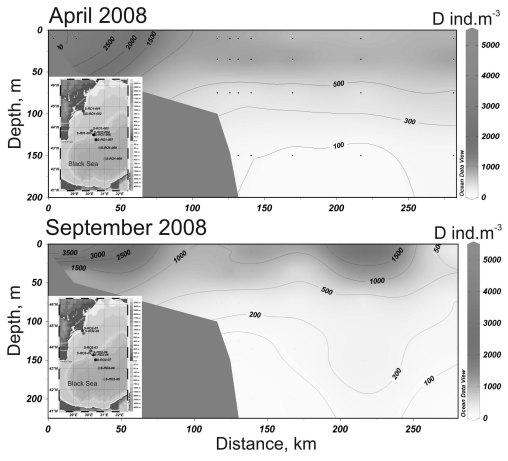


Fig. 1. Average density of zooplanktonic populations' distribution in the water column in the area investigated

The analysis of taxonomic groups evidenced the numerical dominance of copepods and cladocerans. Of these, 8 species were most abundant, comprising almost 86% of the total average density. These are *Noctiluca scintillans*, *Penilia avirostris*, *Pleopis polyphaemoides*, *Acartia clausi*, *Pseudocalanus elongatus*, *Paracalanus parvus*, *Calanus helgolandicus* and *Synchaeta littoralis*. In both seasons was evincesed a greater diversity in September (22 taxa) than in April (14 taxa). Opposite, the numerical abundances were greater in spring (752.96 $indv.m^{-3}$) than in autumn (667,6 $indv.m^{-3}$), due to Danube debits which positively influenced the abundance of planktonic populations through nutrients aport for phytoplankton and rotifers proliferation. Distribution in the water column down to 200m deep in both seasons evidenced that the diversity and also numerical abundance (2,350 $ind.m^{-3}$) were highest in the surface layer (50-0m) in April (Fig. 1). *N.scintillans*, *S.littoralis*, *P.avirostris*, *P.polyphaemoides* and *A.clausi* were the main species that formed the littoral nucleus. These species has a great adaptation potential and quickly response related to climate factor variability, their proliferation being enhanced by the blooming events and warming tendency. In September the highest densities recorded (1,867 $ind.m^{-3}$) were distributed in the first 25m depths.
In the ecological conditions of April 2008, vertically distribution of zooplankton had maximum biomasses in 100-50 m layer while that in September at 50-0 m depth. This suggests that in September was still a suitable temperature for populations of zooplankton, which mainly develop in summer season. *N. scintillans*, *C.helgolandicus*, *Pleurobrachia rhodopis*, were the dominant species after biomass (Fig.2).

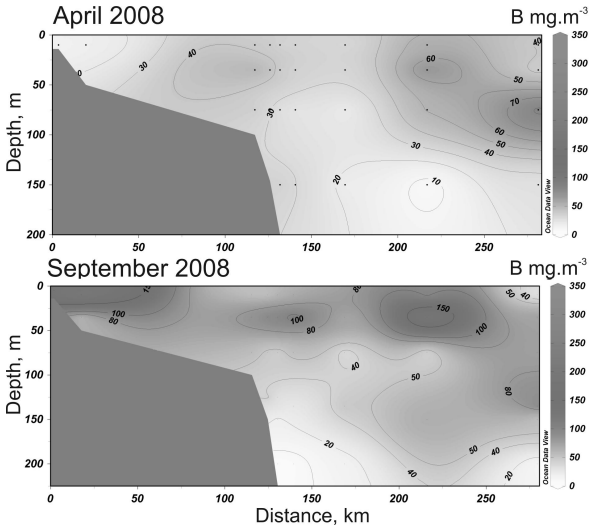


Fig. 2. Average biomass of zooplanktonic populations' distribution in the water column in the area investigated

Acknowledgements: This study has been financially supported by SESAME project. The author benefited from the support offered by Professor Marian-Traian GOMOIU.

References
1 - Cushing, D. H., 1990. Plankton production and year-class strength in fish population: an update of the match/mismatch hypothesis. *Adv. Mar. Biol.* 26: 250–293.

DIFFERENCES IN REPRODUCTION CYCLE BETWEEN SARDINE *SARDINA PILCHARDUS* WALB. 1792 AND GILT SARDINE *SARDINELLA AURITA* VAL. 1847 IN THE MIDDLE EASTERN ADRIATIC

Bosiljka Mustac [1]* and Gorenka Sinovcic [2]
[1] Adria d.d.company for catching, processing and trade of fish - bmustac@yahoo.com
[2] Institute of Oceanography and Fisheries

Abstract
This paper presents a comparison between reproduction cycle of sardine *Sardina pilchardus* and gilt sardine *Sardinella aurita* in the Adriatic Sea. Based on the greatest values of gonadosomatic index, sardine spawned from October to May, while gilt sardine reproduction started in June and lasted until September. The average cubic condition coefficient for sardine was K=0.7702 ± 0.05 and for gilt sardine K=0.7382 ± 0.05.
Keywords: Adriatic Sea, Reproduction, Fishes

Introduction
The aim of this study was to identify the differences between *Sardina pilchardus* and gilt sardine *Sardinella aurita* length, gonad and body weight, gonadosomatic index and condition factor in the Middle eastern Adriatic Sea. In the Adriatic Sea, sardine is one of the most abundant species, while gilt sardine is invasive and under-represented [1, 2].
Both fish specimens take the same ecological niche and are caught together by purse seines. They spawn at a completely different time of year and their condition values differ through the whole analyzed period.

Material and methods
All of the fishes were obtained from the catches of inshore (Virsko more) and offshore waters (Dugi Otok) in the Middle eastern Adriatic Sea, from March 2004 to January 2009. A total of 1,219 sardine and 2,033 gilt sardine specimens were measured to the nearest mm and weighed to the nearest g. The monthly gonadosomatic index (*GSI*) was calculated by the monthly gonad weight (*Wg)* as a proportion of the total body weight (*W*): $GSI = 100\ Wg / W$. The cubic condition factor (*K*) was calculated using Fulton`s coefficient $K = 100W\ L^{-3}$. To avoid the bias caused by fish size (*L*) in the condition analysis, only sardines between 14.0 and 18.0 cm, and gilt sardines from 18.0 to 28.0 cm *LT* were used to compare condition changes.

Results
Sardine and gilt sardine total lengths and body weights ranged from 13.0 to 19.0 cm (mean=16.0 ± 0.9 cm) and from 16.7 and 51.5 g (mean=31.5 ± 5.3 g), then from 10.0 to 32.5 cm (mean=22.0 ±3.7cm) and from 6.43 to 298.32 g (mean=85.77 ± 37.5 g), respectively. Sardine *GSI* showed greatest value in July (3.38%) and lowest in February (0.37%). Gilt sardine *GSI* ranged from 0.41%-July to 4.32%-December (Fig. 1).

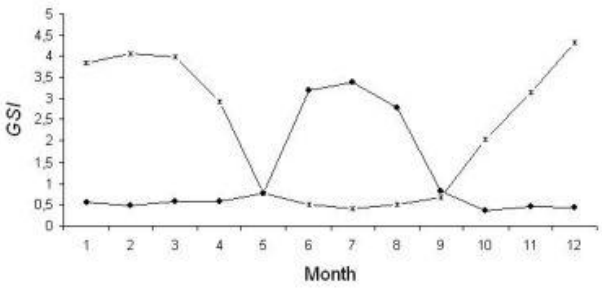


Fig. 1. GSI of sardine (*) and gilt sardine (•), Middle eastern Adriatic Sea, 2004-2009

The average cubic condition coefficient (*K)* of sardine varied from 0,6939 (January) to 0.8282 (September) (mean K=0.770 ± 0.05), and of gilt sardine from 0.6515 (February) to 0.8025 (January) (mean K=0.738 ± 0.05) (Table 1).

Tab. 1. Average monthly cubic condition factor (*K*) of sardine and gilt sardine from the catch samples of the Middle eastern Adriatic Sea, 2004-2009

Month	Cubic condition factor *K*	
	S. aurita	*S. pilchardus*
January	0.8025	0.6939
February	0.6515	0.7149
March	0.6915	0.7618
April	0.7202	0.7561
May	0.7099	0.7627
June	0.7744	0.8375
July	0.7165	0.7848
August	0.7657	0.8215
September	0.7544	0.8282
October	0.7570	0.7848
November	0.7981	0.7266
December	0.7175	0.7698
mean	0.7382	0.7702
SD	0.045	0.045

Discussion
According to this study there were differences between sardine and gilt sardine spawning season and its duration. Sardine spawns during the winter months (from October to May), whereas gilt sardine spawns in summer (from June to September) [3]. Gilt sardine spawning period lasts longer in warmer waters compared to the ones with a lower average temperature [1, 4, 5].
In general, sardine showed greater values of cubic condition factor during summer months than during the winter (spawning) period. Condition of gilt sardine was also better after spawning (October-November); its greatest value was noticed in January (K=0.803).

References
1 - Sinovcic G., Franicevic M. and Cikeš Kec V., 2004. Unusual occurrence and some aspects of biology of juvenile gilt sardine (*Sardinella aurita* Valenciennes, 1847) in the Zrmanja River estuary (eastern Adriatic). *J. Appl. Ichthyol*., 20 (1): 53 – 57.
2 - Cingolani N., Kariš T., Sinovcic G. and Kapedani E., 2003. Sardine (*Sardina pilchardus*,W.) stock assessment in the Adriatic Sea: 1975-2002.AdriaMed. Occasional Papers (Eds. Mannini P. Massa F. Milone N.) 1: 1-11.
3 - Mužinic R., 1954. Contribution à l`etude de l`écologie de la sardine (*Sardina pilchardus* Walb.) dans l` Adriatique orientale. *Acta Adriat*., 5 (10): 1-219.
4 - Tsikliras A. C. and Antonopoulou E., 2006. Reproductive biology of round sardinella (*Sardinella aurita*) in the north-eastern Mediterranean. *Sci. Mar*., 70 (2): 281-290.
5 - Quaatey S. N. K. and Maravelias C. D., 1999. Maturity and spawning pattern of *Sardinella aurita* in relation to water temperature and zooplankton abundance off Ghana, West Africa. *J. Appl. Ichthyol*.,15: 63-69.

EVOLUTION DES PROFILS DES DEBARQUEMENTS DE POISSONS DANS LA REGION DE GABES, TUNISIE

Besma Najar [1]*, Ben Mariem Sadok [2] and Hadj Ali Mohammed [3]
[1] institut national Agronomique de Tunis - najar_besma8@yahoo.fr
[2] Institut National des Sciences et Technologies de la Mer, 2025, Salammbó, Tunisie
[3] Système d'Information pour la Promotion de l'Aquaculture en Méditerranée

Abstract
Le golfe de Gabès est un pôle important de la pêche maritime tunisienne puisqu'il représente environ 40 % en poids et 50 % en valeur de la totalité des apports. Une exploitation de la crevette (*Penaeus kerathurus)* s'est développée, notamment, depuis les années 1980 entraînant des changements quantitatifs et qualitatifs profonds du profil des pêches. En vue d'analyser ces changements, des données sur les captures de cette région ont été recueillies depuis le début du développement de l'exploitation de la crevette (1980) jusqu'aux années 2000.
Keywords: Fisheries, Gulf Of Gabes

Les données utilisées dans cette étude proviennent :
- des statistiques de pêche collectées auprès des services de la Direction Générale de la Pêche et de l'Aquaculture (DGPA) [1].
- des campagnes de chalutages expérimentaux réalisées par l'Institut National des Sciences et Technologies de la Mer (INSTM) [2], [3], [4], et [5].

Les résultats obtenus dans la région de Gabès montrent que, durant la période étudiée, les profils des débarquements de cette région ont subi de réelles modifications quantitatives et qualitatives dont les plus importantes sont :
- un appauvrissement de la diversité biologique des débarquements de la pêche benthique (fig.1) alors que cet appauvrissement est moins ressenti pour les pêcheries pélagiques (fig.2). La régression de la biodiversité est traduite par la baisse du nombre d'espèces pêchées. Ainsi, certaines espèces comme le mérou, le merlu, les rascasses et certains sparidés ne figurent plus dans les prises ou sont en nombre insignifiant.
- une abondance beaucoup plus importante des espèces à faible longévité comme les crevettes et les céphalopodes au dépend des espèces à grande longévité (poissons benthiques, merlu, mérou, pageot,…).
- la régression de la part relative de la pêche côtière dans les débarquements du Golfe alors que celle du chalutage s'est substantiellement développée. Notons que ce dernier est beaucoup moins sélectif du point de vue inter-espèces et intra-espèce.
- les tailles moyennes de nombreuses espèces benthiques ont sensiblement diminuées dans les captures et par conséquent la biomasse du stock des géniteurs pourrait être affectée.

Ces résultats constituent des indicateurs importants pour le diagnostic de l'évolution des pêcheries du golfe de Gabès ; ils mettent en exergue la fragilité actuelle de l'écosystème de cette région. En outre, ils fournissent des éléments précieux pour améliorer la gestion des pêcheries de cette région et préserver leur durabilité.

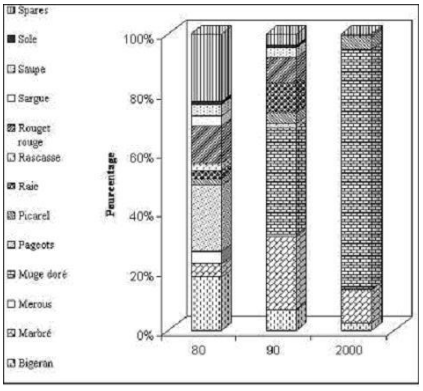


Fig. 1. Variation da la composition spécifique des débarquements de poissons benthiques de la région de Gabès durant les années 1980, 1990 et 2000

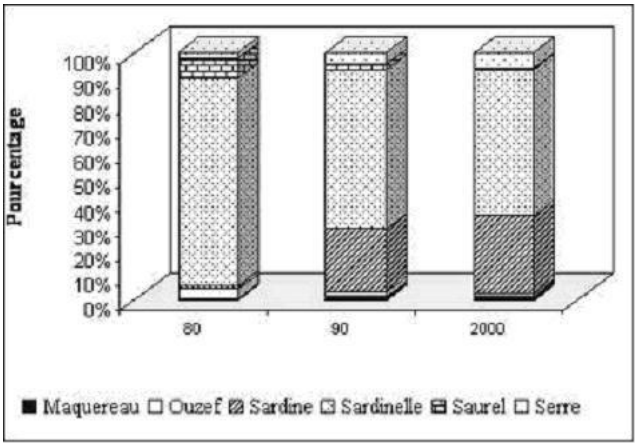


Fig. 2. Variation da la composition spécifique des débarquements des petits poissons pélagiques de la région de Gabès durant les années 1980, 1990 et 2000

References
1 - Annuaires statistiques de la direction générale de la pêche et de l'aquaculture (DGPA) 1980-2006.
2 - Ben Meriem S. et Gharbi H., 1982. Analyse préliminaire des résultats de chalutage du "Hannoun" dans le Golfe de Gabes du 2 au 22 Août 1988. *rapp.doc.Inst. Natn Scient. techn. oceanogr. Pêche Salambo*, 3:1-34pp.
3 - Gharbi H. & Ben Meriem S., 1996. Résultats de chalutage expérimentaux de mai - Juin 1996 dans le Golfe de Gabes.*Bull. Inst. Natn Scient. techn. oceanogr. Pêche Salambo*, vol (23) N°2: 80-96p.
4 - Jarboui O. et Gharbi H., 2002. Prospection benthique dans la région du Golfe de Gabes.*Bull. Inst. Natn Scient. techn. oceanogr. Pêche Salambo*, 12p.
5 - Zaouali J., 1992. Résultats des prospection du mois de Juilet 1990. les peuplements benthiques , étude préliminaire. *Mar. life*, 1:53-56 pp.

TROPHIC RELATIONS OF WILD FISH ASSOCIATED TO AN OPEN-WATER FISH FARM IN THE SOUTHWESTERN MEDITERRANEAN

F. Navarrete-Mier [1]*, C. Sanz-Lázaro [1], M. Belando [1], D. Celdrán [1], P. Sánchez Morillo-Velarde [1] and A. Marín [1]
[1] Departamento De Fisiología Animal, Facultad De Biología, Universidad De Murcia, 30100 Murcia, Spain - kfrancisco.navarrete@um.es

Abstract
The aim of this work was to determinate the trophic relationships of wild fishes associated to an open sea fish farm. We take samples of cultured and wild fishes in an ecological gradient to analyze his contents of stable isotopes of carbon and nitrogen. This study showed how the influence of the uneated feed of net-cages change the normal trophic behaviour of associated wild fishes.
Keywords: Aquaculture, Food Webs, Fishes

Introduction
The fish farms in open sea attract an unusual ichthyc biomass [1]. The reason of this attraction is not clearly identified, nevertheless is possible that the high protein food lost through the cages could have an elevated attractable effect on the wild fishes. The presence of a high number of fish-farms in the Mediterranean Sea, make indispensable more studies related to this system and the trophic structures in wild fish associates [2].

In studies of marine ecology, stable isotopes analyses have emerged as reliable tools for elucidating trophic structure and inferring pathways of energy flow in food webs. $\delta^{13}C$ allows differentiates the carbon source, while $\delta^{15}N$ permit us assess the relative trophic position of an organism. Thus nitrogen and carbon stable isotopes can provide us the time-integrating fish's trophic interactions [3].
The objectives of this study were to determinate if the fish consume the products of the net-cages and to trace its influence related to the distance of the culture. It was measured by the content of stable isotopes in pelagic fish associated to the fish farm, which also allows us an approaching to explain at specific and community level how the net cages influences on the trophic relationships of wild fish.

Materials and methods
This study was carried out in the surroundings of a marine fish farm located in Águilas, SE Spain, (western Mediterranean; 37º 24' 56.2" N, 1º 32' 4.0" W), which produces gilthead sea bream (*Sparus aurata*) and European sea bass (*Dicentrarchus labrax*). We defined four stations for analyses: (I) Inside the cages, (O) Outside the cages (ca, 90 m around the net-cages), (F) Fraile Island (750 m to the west to the net-cages), and (C) Cape Cope (2500 m to the east from the net-cages) as control station. At each station, the diversity and abundance of the fish community were valuated by visual techniques. Also we take samples of white muscle of each species of fish and freeze-dried it for stable isotopes analyses. The carbon and nitrogen isotope ratios of the samples were measured with an elemental spectrometer of isotopic relationships Delta^{plus} (ThermoFinnigan). All the isotopic data were reported in the conventional δ notation. δ13C values were reported as the deviation relative to the Vienna Pee Dee Belemnite Limestone Standart (v-PDB), while δ15N standards were calibrated and results were reported relative to atmospheric nitrogen.

Results and discussion
The higher wild fish abundance was found closed to the fish farm, demonstrating the attraction effect of the open water aquaculture. The community structure of wild fish also changed depending of distance from fish farm. The isotopic analyses of $\delta^{13}C$ and $\delta^{15}N$ showed a tendency to major accumulation of carbon isotopic in fishes of stations away from the net cages.
The spatial pattern of $\delta^{15}N$ did not exhibit clear differences between stations (Figure 1). The changes in the isotopic concentrations were accompanied by a notorious compression of the trophic niche of fish communites closer to the artificial feed source (Figure 2).

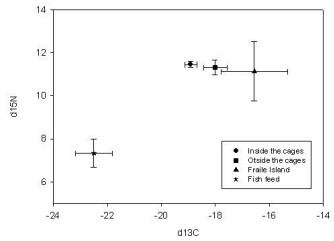


Fig. 1. Bi-plot of $\delta^{13}C$ and $\delta^{15}N$ accumulation (mean ± SE n=4), for European sea bass (*Dicentrarchus labrax*) and fish feed

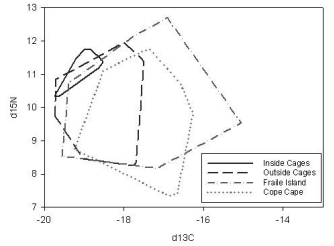


Fig. 2. Dispersion of fish community content of carbon and nitrogen stable isotopes in each station. These results are representative of 89 fish and 19 species

This adaptative behaviour of wild fishes to an artificial source of food would imply ecological consequences that should be deeply analyzed.

Acknowledgements: We thank Culmarex SA.. Supported by the Programme AlBan, the European Union Programme of High Level Scholarships for Latin America (FNM scholarship No.E07D401236EC).

References
1 - Dempster, T., Sanchez-Jerez, P., Bayle-Sempere, J., Giménez-Casalduero F., Valle, C., 2002. Attraction of wild fish to sea-cage fish faros in the south-western Mediterranean Sea: spatial and short-term temporal variability. *Mar. Ecol. Progr. Ser.*, 242: 237-252.
2 - Tuya, F., Sanchez-Jerez, P., Dempster, T., Boyra, A., Haroun, R., 2006. Changes in demersal wild fish aggregations beneath a sea-cage fish farm after the cessation of farming. *Journal of Fish Biology*, 69, 682-697.
3 - Lefebvre, S., Harma, C., Blin, J.-L., 2009. Trophic typology of coastal ecosystems based on δ13C and δ15N ratios in an opportunistic suspension feeder. *Mar. Ecol. Progr. Ser.*, 390, 27-37.

INVESTIGATING THE FOOD WEB IN THE NW MEDITERRANEAN SEA WITH STABLE ISOTOPES AND MODELLING RESULTS

J. Navarro [1]*, M. Coll [2], M. Louzao [3], M. G. Forero [4], D. Oro [3] and I. Palomera [1]
[1] ICM-CSIC, P. Marítim de la Barceloneta 37-49, 08002 Barcelona, Spain - joan@ebd.csic.es
[2] Dalhousie University. 1355 Oxford Street. Halifax, Nova Scotia. B3H 4J1 Canada
[3] EBD-CSIC, Av. Américo Vespucio, s/n, 41092, Sevilla, Spain
[4] IMEDEA (CSIC-UIB), C/ Miquel Marquès 21, 07190 Esporles, Mallorca, Spain

Abstract

In the present work we described the marine food web structure of the Ebro Delta marine area by applying; (1) an ecological model and (2) stable isotope analyses. Stable isotope analyses provide information of the predator-prey relationships and the foraging areas of each species in the food-web. The ecological model also delineated the food web structure of each species by estimating their trophic level. We showed some discrepancies and similarities between both approaches. In conclusion, both methodologies were insightful to describe the food-web traits of the Southern Catalan Sea and enabled us to complement our understanding of the area and to validate our results.

Keywords: Food Webs, Ebro Delta, Carbon, Models, Predation

Introduction

Due to the importance of predator–prey relationships and their dynamics on the evolution and structure of marine communities, ecologists have focused their research into different aspects of food webs to determine the influence of the community structure on it stability, complexity, connectivity and equilibrium. In the present communication, by using two complementary approaches, ecological modelling (with EwE: Ecopath with Ecosim) and stable isotope analyses (SIA:$\delta^{15}N$ and $\delta^{13}C$ values), we described the food web structure of the Southern Catalan Sea (NW Mediterranean). We compare results from both tools regarding abundant marine species in the area.

Material and methods

The study was conducted in the continental shelf of the Ebro Delta (ED) marine area (NW Mediterranean). To establish the predator-prey relationships among the different marine species we analyzed both $\delta^{15}N$ and $\delta^{13}C$ values from different marine species of the ED; 16 fish and 1 seabird species (the Audouin's gull) sampled in the ED during 2003. We used published SIA values of 3 predators species;the bottlenose dolphin [1], the loggerhead sea turtle [2] and the Balearic shearwater [3]. EwE was used to model this area and described the structure and functional traits of the food web [4], calculating the trophic level of each species.

Results and Discussion

By using SIA method we depicted the predator-prey relationships among the different species of the food web in the ED. As expected, $\delta^{15}N$ values indicated that bottlenose dolphin, Audouin's gull and the group composed by other seabirds were located at the top of the food web, while sardine, benthopelagic fish and the other demersal and pelagic fish and cephalopods were located at the base of the food-web or at intermediate positions (Fig. 1). Moreover, $\delta^{13}C$ values helped to determine the foraging areas of each species, in relation to their pelagic or benthic localisation; the low $\delta^{13}C$ values of Audouin's gull and anchovies indicated that these species fed on pelagic waters, whereas the high $\delta^{13}C$ values showed in the loggerhead sea turtle and the benthopelagic cephalopods indicated that these species fed on benthic waters (Fig. 1).

The EwE approach showed some discrepancies and similarities with the stable isotope approach. For several groups, the TL values estimated in the EwE were similar to the estimated by SIA method (i.e. the loggerhead sea turtle or the bottlenose dolphin). However, the EwE showed lower TLi for the seabirds suggesting that seabird species were located at the base of the food web. This is a artefact in the EwE due to consideration of the discards, the main food for the studied seabirds, with very low trophic level value (TL=1) because we did not did not considered demersal and pelagic fish in the discards. Thus, the real trophic position of seabirds in the area may be around TL=4.

In conclusion, both methodologies were insightful to describe the food-web traits of the ED and enabled us to complement our understanding of the area and to validate our results.

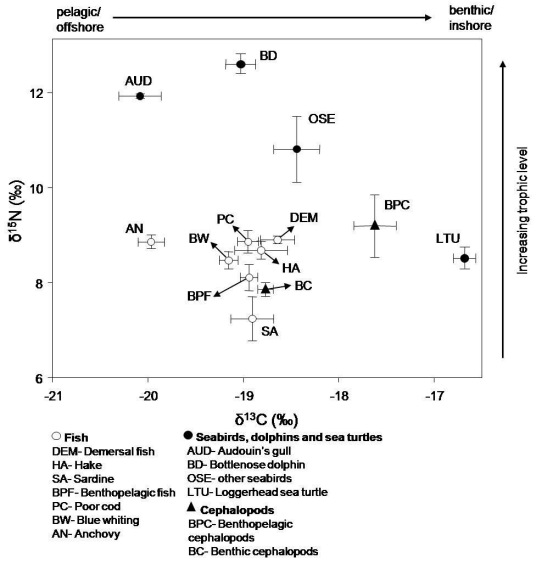


Fig. 1. Carbon and nitrogen isotope values of fish, seabirds, dolphins, sea turtles and cephalopods from the Ebro Delta (NW Mediterranean) during 2003.

References

1 - Borrell A., Aguilar A., Romero V., Sequeira M., Fernández G. and Alis S., 2006. Organochlorine compounds and stable isotopes indicate bottlenose dolphin subpopulation structure around the Iberian Peninsula. *Environ. Int.*, 32: 516-523.

2 - Revelles M., Cardona L., Aguilar A., Borrell A., Fernández G. and San Féliz M., 2007. Stable C and N isotope concentration in several tissues of the logerhead sea turtle *Caretta caretta* from the western Mediterranean and dietary implications. *Sci. Mar.*, 71: 87-93.

3 - Navarro J., Louzao M., Igual J.M., Oro D., Degado A., Arcos J,M., Genovart M., Hobson K.A. and Forero M.G., 2009. Seasonal changes in the diet of a critically endangred seabird and the importance of trwling discards. *Mar. Biol.*, 156: 2571-2578.

4 - Coll M., Palomera I., Tudela S. and Dowd M., 2008. Food-web dynamics in the South Catalan Sea ecosystem (NW Mediterranean) from 1978-2003. *Ecol. Model.*, 217: 95-116.

SPAWING INDUCTION, FERTILIZATION AND LARVAL DEVELOPMENT OF *HEDISTE DIVERSICOLOR* (NEREIDIDAE, POLYCHAETA) UNDER DIFFERENT EXPERIMENTAL CONDITIONS

N. Nesto [1]*, A. Libertini [1], D. Prevedelli [2], R. Simonini [2] and C. Tola masala [3]
[1] Institute of Marine Science, National Research Council - nicoletta.nesto@ve.ismar.cnr.it
[2] Department of Animal Biology, University of Modena and Reggio Emilia
[3] International Marine Centre, Torregrande, Oristano

Abstract
A suite of experiments with the polychaete *Hediste diversicolor* were performed to assess the induction of gamete spawning by endogenous substances, to evaluate the percentage of fertilised and hatching eggs in two different conditions ("natural" and *in vitro* fertilization), and to measure the density effects on larval growth and survival. The results showed that mature females were induced to spawn by adding mature male tissue homogenate in the medium. The percentages of fertilised and hatching eggs were higher in the *in vitro* fertilisation and larval/juvenile survival was affected by density.
Keywords: Polychaeta, Larvae, Reproduction

Introduction
The ragworm *Hediste diversicolor* is a polychaete belonging to the Nereididae family which is used and appreciated as commercial bait for fishing [1]. This gonochoric species has a holobenthonic life-cycle and can be easily reproduced in laboratory conditions [2]. A series of laboratory experiments were performed to standardize a number of biological parameters to be included in rearing technical procedures.

Materials and Methods
The influence of endogenous substances on gamete spawning was evaluated in sw aquaria at 16 psu and 16°C, where individual mature females and males were separately exposed to homogenates made up with whole mature organisms, male and female respectively, up to one week.
To evaluate the influence of different fertilisation conditions ("natural" and *in vitro*) on the percentage of fertilised and hatching eggs two types of experiments were performed. In the first one pools of mature female and male organisms were introduced in aquaria with glass tubes on the bottom reproducing the natural burrows within which the whole organism life-span occurs. In the second type of experiments, naturally spawned eggs were fertilised *in vitro* with a sperm suspension obtained from mature males. The fertilisation occurred in a becker containing 0.5L of filtered (0.2 µm) sw at 16 psu and 16°C. For both experiments, 6 replicates of 100 eggs were collected and the larval development was followed until nectochaete hatching.
To test the influence of density on the development and survival of nectochaetes the following experiment was performed. The sw aquaria (16 psu and 16°C) were provided with biological filters and 2 cm of fine sand sediments. Groups of ten-days nectochaetes were established in order to obtain two experimental densities: 5200 ind/m^2 (3 replicates) and 10400 ind/m^2 (2 replicates). Organisms were fed *ad libitum* using commercial fish feed (classic C22, Hendrix) three times a week for 8 weeks. Survival and growth rate were checked at the end of the experiment.

Results and Discussion
The results of the spawning experiments showed that the percentage of spawned animals, determined at the end of the experimental period, was significantly higher than in the controls only for females (57% *vs* 14%), indicating preliminarily that mature females were susceptible to spawning induction by a likely mixture of not determined endogenous compounds.
The results of the fertilisation experiments showed that the percentages of fertilised (64-91%) and hatching eggs (46-88%) obtained from the "natural" fertilisation experiment were always lower than the ones from the *in vitro* fertilisation, when the values ranged from 94-100% (fertilised eggs) and 94-99% (hatching eggs). This may be tentatively explained by a safer microbiological condition of the medium in the second experiment, as suggested by the observed minor number of swimming protozoa.
The growth rates of nectochaete maintained at two densities showed similar values, and juveniles reached a mean fresh weight of 30 mg in 8 weeks. On the contrary, density affected the mortality rates of nectochaetes and juveniles, survival resulting in the ranges of 57-81% and 53-57 % at low and high density, respectively.

References
1 - Scaps P., 2002. A review of the biology, ecology and potential use of common ragworm *Hediste diversicolor* (O.F. Müller, 1776) (Anellida: Polychaeta). *Hydrobiologia*, 470: 203-218.
2 - Fidalgo e Costa P., 1999. Reproduction and growth in captivity of the polychaete *Nereis diversicolor* O.F. Müller, 1776, using two different kinds of sediment: preliminary assays. *Bol. Inst. Esp. Oceanogr*.,15 (1-4): 351-355.

MONITORING OF ZOOPLANKTON IN THE COASTAL AREA OF THE NE BLACK SEA IN 2005-2009.

Anastasia Nikishina [1]*, Elena Arashkevich [1] and Nora Louppova [2]
[1] Shirshov Institute of Oceanology, Russian Academy of Sciences - anastasia.nikishina@gmail.com
[2] Shirshov Institute of Oceanology RAS, Southern Branch

Abstract
The monitoring of the zooplankton community was conducted from June 2005 to October 2009 in the North-East Black Sea coastal area. Samples were taken along the cross-shelf transect at three stations. In the present work we studied the intensity of the cross-shelf exchange of the zooplankton in different seasons, seasonal changes in the zooplankton community and made a comparison of the present and past state of the zooplankton in this region.
Keywords: Zooplankton , Black Sea, Coastal Systems

Introduction
It is known, that shelf pelagic ecosystems are very productive, in different basins they provide up to 80% of the total production. In the Black Sea, where the most of the water column is contaminated by hydrogen sulfide, the productive abilities of the basin are limited. So the processes that take place on the shelf and continental slope play the key role for the whole basin. The Caucasian sector of the Black Sea has a narrow shelf with width of 3-5 miles and a steep slope. Due to the bottom topography, the hydrodynamic processes (generation of eddies, cross and along shelf water exchange) are very active in this region [4, 1]. That's why the distribution of the zooplankton is very heterogeneous and the species composition changes very quickly in the coastal area. Pelagic system of the Black Sea has changed dramatically during the last decades. The invasion of ctenophore *Mnemiopsis leidyi* in the middle of eighties caused significant decrease in zooplankton biomass and led to the changes in species composition of zooplankton. The invasion of ctenophore *Beroe ovata* feeding on Mnemiopsis led to the enhancement of zooplankton community in the end of nineties. The detailed monitoring of the coastal ecosystem has not been conducted since 1994. This work was aimed to reveal the cross shelf exchange of zooplankton in the different seasons; to study the seasonal changes in zooplankton community in the different regions of the coastal zone (inner shelf, middle shelf and continental slope); to make an assessment of the current state of zooplankton community.

Methods
Zooplankton sampling along with CTD probes were done monthly from June 2005 to October 2009. Zooplankton was collected with a Juday net (mouth area 0.1 m^2, mesh 180 μm) at three stations located over the inner shelf, middle shelf and continental slope along the transect off Geledzhik. Zooplankton were identified to species level and counted under the dissecting microscope.

Results
Zooplankton composition differed significantly over the shelf and the continental slope. Bathypelagic species were mostly found over the slope while the surface dwelling species were distributed evenly along the transect. Seasonal changes in species composition were more pronounced over the shelf than over the slope because of decline/disappearance of these species in winter. The seasonal dynamics of zooplankton biomass differed from year to year. On average, two biomass maxima were observed during a year and the autumn maximum was higher than the spring one (fig. 1).

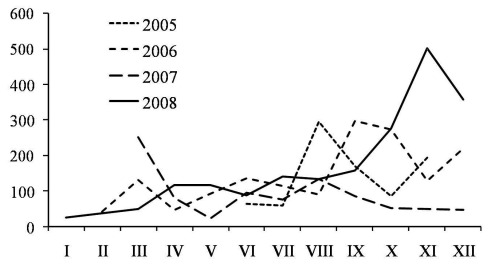


Fig. 1. The seasonal dynamics of the zooplankton biomass in different years

High values of zooplankton biomass in 2005 and 2006 as compared with the average biomass for the last 50 years indicates the recovery of plankton community after its collapse in the 90-s. There were some differences in species composition and seasonal dynamics of zooplankton between these periods. In 1991-1994, cladoceras shrank and chaetognaths virtually vanished from zooplankton. The share of these species in the total biomass was higher in 2005-2008 than in 1970's. Populations of Oikopleura and meroplankton have also decreased since 1970's, these populations haven't recovered yet. In 1970's maxima of plankton biomass were observed in April and August-September [3]. In 1991-1994's maximum of plankton biomass was observed in March, another small peak was observed in October [2]. In 2005-2009 plankton biomass was the highest in September-November (fig.2).

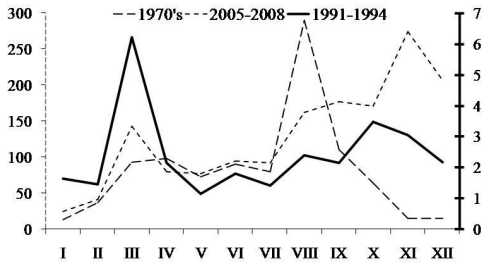


Fig. 2. The seasonal dynamics of the zooplankton biomass in different periods

Conclusions
In the study period, the cross-shelf exchange was very intensive, since the distribution of zooplankton was even in the upper mixed layer. The hydrophysical conditions played the important role in zooplankton distribution along the transect. The considerable interannual changes in seasonal dynamics of zooplankton community in 2005-2009 were evidence of the life cycle plasticity and seasonal shift in reproduction of dominant species. At present, zooplankton abundance and biodiversity have recovered after the collapse of 1991-1994, and reached the values observed in 1970-es before the alien ctenophore invasion.

References
1 - Arashkevich E.G., Timonin A.G., Zatsepin A.G., Kremenetskiy V.V., Drits A.V., 2005. Effect of the Rim Current regime on the zooplankton distribution in the "shelf-slope-deep sea" system in the Black Sea. Oceanology, vol. 45, Suppl. 1. pp 149-160.
2 - Horoshilov V.S., Lukasheva T.A., 1999. Changes in zooplankton community of the Blue Bay after the invasion of ctenophore Mnemiopsis in the Black Sea. Oceanology, vol. 39, ?4, pp 567-572 (in russian).
3 - Pasternak A.F., 1983 Seasonal dynamics of zooplankton abundance and biomass of Northern Caucasus coastal area. In: Seasonal variations of the Black Sea plankton. Moskva, Moscow, pp 139-177 (in russian).
4 - Zatsepin A. G., Ginzburg A. I., Kostianoy A. G., *et al.*, 2002. Variability of Water Dynamics in the Northeastern Black Sea and Its Effect on Water Exchange Between the Nearshore Zone and Open Basin, *Oceanology* 42 Suppl. 1, pp 1–15.

ANCHOR DAMAGE ON *POSIDONIA OCEANICA* (L.) DELILE BEDS IN THE GOKOVA BAY

E. Okus [1], S. Zeki [2]*, V. Demir [2], N. Demirel [1], A. Yüksek [1], I. N. Yilmaz [1], A. A. Yilmaz [3], S. Ü. Karhan [4], A. E. Müftüoglu [1], U. Tural [1], E. Murat [1] and C. Gazioglu [2]

[1] Istanbul University, Institute of Marine Sciences and Management, Department of Marine Environment - szeki@yahoo.com

[2] Istanbul University, Institute of Marine Sciences and Management, Department of Physical Oceanography and Marine Biology

[3] Michigan State University, Department of Fisheries and Wildlife

[4] Istanbul University, Department of Biology

Abstract

Posidonia oceanica (L.) Delile is the most widespread seagrass in the Mediterranean Sea. It plays an important role in ecosystems of shallow coastal waters in several ways. Experimental evaluations about the impact of anchors of sea vessels have previously shown that each anchoring can on average damage up to six shoots of *Posidonia oceanica*, removing small amount of biomass and, at the same time, interrupting continuity among shoots [1]. When the density of *P.oceanica* meadows is decreased and their state of being well is damaged, the stability of the environment is ruined and loss of habitat occurs. The aim of the study was to determine the effects of boat anchoring on *P. oceanica* seagrass beds on Gokova SPA between 2005-2006.

Keywords: Posidonia, Eastern Mediterranean

Introduction

The endemic seagrass species of Mediterranean basin *Posidonia oceanica* (L.) Delile covers about 2% of the seafloor of Mediterranean Sea [2]. It plays an important role in ecosystems of shallow coastal waters in several ways by providing habitat for a highly diverse fauna and flora; significantly reducing coastal erosion and offering a nursery area for many fish and invertebrate species [3]. Current main threats to the *P. oceanica* habitat are related to: water and sediment enrichment (eutrophication), the disruption of the sedimentation/erosion balance along the coast and direct destruction by human modifications of the coastline, degradation by boat trawling and anchoring [4]. Major damage to seagrasses seems to be caused by dragging anchors and scraping anchor chains along the bottom, as boats swing back and forth [5]. *Posidonia oceanica*, removing small amount of biomass and, at the same time, interrupting continuity among shoots [1]. The aim of the study was to determine the damage caused to *P. oceanica* habitat coverage by anchoring.

Materials and Methods

This study is based on the project "Coastal and Marine Biological Diversity Assessment of Gokova Specially Protected Area". The study was carried in 3 sampling periods between 2005 and 2006 (June-July 2005, April-May 2006 and June-July 2006). 309 scuba dives and 128 skin dives were performed on 220 km coastline of bay during total 75 days. Estimation of *P. oceanica* coverage and anchor damage was done by visual census method. For indicating the dimention of damage, Geographic Information system ArcGIS, was used for mapping and demonstration of sampling and remark data.

Results

It was determined that *P. oceanica* meadows has especially turned the severe marine environment into a more stable environment and ensured it to be used as a habitat for almost all species in the Gokova SPA. When the distribution of *P. oceanica* is decreased and their state of being well is damaged due to the various reasons, the stability of the environment is ruined and the loss of habitat occurs; because of those significant changes occurred in a very short period, biotopes and habitats begin to collapse rapidly. All those events result in the grave changes in the biota. In the study carried out in the Gökova SPA it was observed that most of the bottom was covered by *P. oceanica*. The average percent coverage was calculated as %61 approximately 6.9 km^2 in the studied area. It was significant that *P. oceanica* coverage decrease when area damaged with boat anchor. The areas most frequently used for the anchorages were determined as the west part of Akyaka (Gokova Bay), Çam Harbor, Sedir Island, Ingiliz Harbor, Tuzla Inlet, Hirsiz Inlet, Yediadalar and Çatalca Inlet. At the same time in those locations *P. oceanica* was widely distributed especially in Sedir Island, Çatalca and Hirsiz inlets and Yediadalar. That the sea grasses widely distributed in the vicinity of Sedir Island were extensively exposed to the impact of the daily tour boats should be observed carefully [Fig.1]. The percent coverage was usually higher in the south part of Gökova Bay where there is no or few anchor damage. In addition no distribution of *P. oceanica* was observed in Ingiliz Harbour, Akyaka (Gökova) Bay and Çamli Bay. This situation was created by both natural and human impacts. *P. oceanica* was under a lot of stress due to the touristic activities in the densely populated locations such as Akyaka, Akbük and the damage caused by the private yachts, the daily tour boats and the Blue Cruise boats during the summer as well. Especially Akyaka Bay has the muddy bottom and a lot of freshwater inputs. The value of transparency is lower. The settlement is extensive; in addition there are a harbor and a shipyard. Especially Ingiliz Harbor, Çam Harbor and Karacasögüt were preferred as the anchorages because of their being sheltered places; apart from the extensive sedimentation due to their semi-closed nature, the anchoring and the other activities also caused damages to *P. oceanica* in those areas.

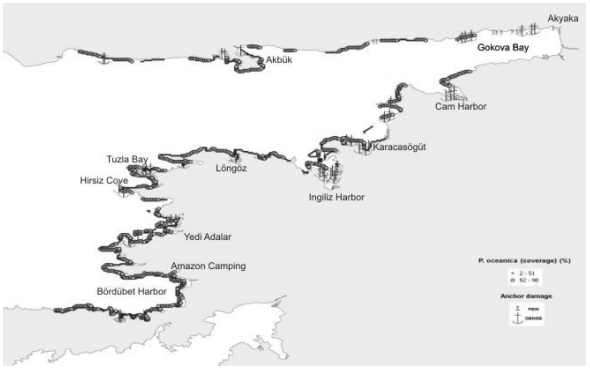


Fig. 1. *Posidonia oceanica* coverage and determined anchor damage along the coasts of Gokova SPA

Discussion

The anchoring should be controlled in the locations with the sea grass meadows given in Figure1. With the aim of the control, the buoys should be fastened to the bottoms in the west part of Akbük Inlet, Ayin Inlet, Löngöz Inlet, Yediadalar Inlet, Amazon Camping and Çati Inlet.

References

1 - C Giulia., C Davide., M Marco., 2007. Short-term response of the slow growing seagrass *Posidonia oceanica* to simulated anchor impact. *Marine Environmental Resea*rch, 63: 341–349.

2 - Larkum A.D, Orth R.J. and Duarte C.M., 2006. Seagrasses: Biology, Ecology and Conservation, Springer Publishing, Nedherlands.

3 - Milazzoa M., Badalamenti F., Ceccherelli G. and Chemelloa R., 2004. Boat anchoring on *Posidonia oceanica* beds in a marine protected area (Italy, western Mediterranean): effect of anchor types in different anchoring stages. *Journal of Experimental Marine Biology and Ecology*, 299: 51-62.

4 - Díaz-Almela E. and Duarte C.M., 2008. Management of Natura 2000 habitats. 1120 Posidonia beds (Posidonion oceanicae). European Commission

5 - Francour, P., Ganteaume, A., Poulain, M., 1999. Effects of boat anchoring in *Posidonia oceanica* seagrass beds in the Port-Cros National Park (north-western Mediterranean Sea). *Aquat. Conserv*. 9, 391– 400.

AUTUMN OVERLAPPING OF *SARDINA PILCHARDUS* AND *MERLUCCIUS MERLUCCIUS* EARLY STAGES IN THE NW MEDITERRANEAN: DISTRIBUTION AND DIET

M. pilar Olivar [1]*, Elvira Morote [1] and Mikhail Emelianov [1]
[1] Institut de Ciències del Mar, CSIC - polivar@icm.csic.es

Abstract

This study analyses the distribution and diet overlap of the early stages of sardine and hake off the Catalan coast during the autumn spawning period. Data on horizontal and vertical distributions of eggs and larvae, the larval size structure in the overlapping zones and the diet composition are examined. Information derived from the study of larval diet was used to discuss the consequences of the overlapping distributions.

Keywords: Ichthyoplankton, Diet, Western Mediterranean

In this study we analyse whether there is overlap in horizontal and vertical distribution of eggs and larvae of sardine and hake, as well as on their larval feeding preferences. Samples were collected in November 2005 off the Catalan coast, by means oblique Bongo (300 µm) hauls in a grid of stations from coastal to slope regions. Stratified samples differentiating water column at 10 m intervals, from surface to 150 m, were also obtained by means oblique hauls using a Longurst Hardy Plankton Recorder (LHPR) (280 µm) performed in a transect carried out following the 200 m isobath. Sardine larvae were the most common and abundant species during the cruise, 97% of occurrence; while hake larvae occur in 67% of the stations. Although the sampling was performed during the spawning period for both species (1, 2), the abundance of sardine eggs and larvae was an order of magnitude higher than that observed for hake. Horizontal egg and larval distributions of both species showed a conspicuous overlap in the shelf-break region. Sardine eggs and larvae were found along all the study region, with higher abundance of earlier stages (eggs and <5 mm larvae) on the shelf region. Hake larval distribution was restricted to the shelf break, while eggs showed a slightly widespread pattern, but with higher abundance also at the shelf-break.

The vertical structure of the water column shows the initiation of the autumn mixing processes, with slight stratification (Fig. 1), under this situation, an important overlap in vertical distributions of eggs and larvae of sardine and hake was evident, both species appearing along the 150 m of the water column, although sardine showed higher concentrations in the first 100 m.

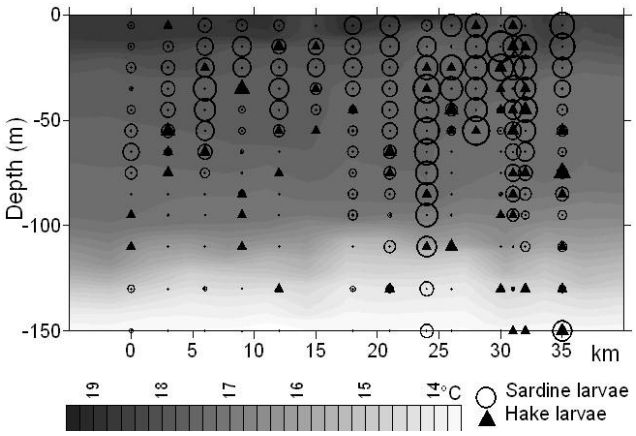


Fig. 1. Vertical distribution of temperature along the 200 m isobath transect, with overlaying sardine and hake larval abundance (log scale). Highest sardine symbol denote 5416 larvae/1000 m^3, and highest hake symbol denotes 108 larvae/1000 m^3

The comparison of the diet composition of the larvae of the two species along their development (sardine larvae from 5.5 to15.8 mm SL and hake from 2.5 to10 mm) showed that there is no overlap in the prey items the feed on (Horn index=0.37). While preflexion sardine larvae (<10 mm) mainly fed copepod nauplii and small preys as tintinnids, small hake larvae (<4 mm) have a diet already based on adult copepods. Larger sardine larvae (from 10-16 mm) showed a shift in their diet to the postnaupliar stages of calanoid copepods like *Clausocalanus* sp. Hake larvae from 3-10 mm continue with a diet based on adult copepods, being *Clausocalanus* sp., by far, the dominant prey, followed by *Paracalanus* sp.

Trophic ecology of hake larvae are influenced by its big mouth and large looped-guts, which allows them to eat and digest a relatively high number of big preys. The feeding incidence in these larvae was significantly higher than in sardine (90>30%). Although there is an important overlap in the distribution of the larvae of both species and sardine larvae are more abundant than hake, we think that there is no competition among larvae of both species because there is no overlapping between their diets (Fig.2, Costello's graphic).

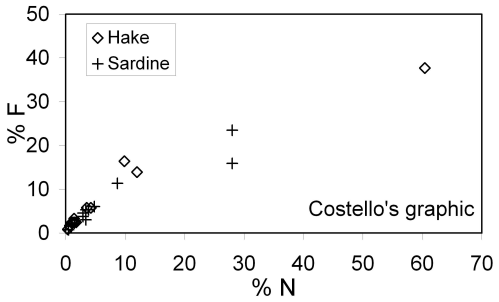


Fig. 2. Diet composition according to Costello's graphic method for *Merluccius merluccius* and *Sardina pilchardus* larvae. N%: Percentage of abundance and F%: Percentage of occurrence of each prey item in the larvae

References

1 - Olivar M.P., Catalán, I.A., Emelianov M., Fernández de Puelles M.L., 2003. Early stages of *Sardina pilchardus* and environmental anomalies in the Northwestern Mediterranean..*Est.Coast. Shelf Sci*., 56: 609–619.

2 - Recasens, L., Chiericone V., Belcari P., 2008. Spawning pattern and batch fecundity of the European hake (Merluccius merluccius (Linnaeus, 1758)) in the western Mediterranean. *Sci. Mar*. 72(4): 721-732.

3 - Costello M.J., 1990. Predator feeding strategy and prey importance: a new graphical analysis. *J. Fish. Biol*., 36:261–263.

THE QUALITATIVE AND QUANTITATIVE STRUCTURE OF ZOOPLANKTON IN THE SHALLOW WATERS OF THE BLACK SEA: COMPARISON OF DATA FROM 1973 AND 2007

Teodora Maria Onciu [1]* and Ciprian Samoila [1]
[1] Ovidius University Constanta - tmonciu@univ-ovidius.ro

Abstract
The paper presents the species diversity and the quantitative structure of the shallow waters zooplankton, which were collected from standard horizons in 10 stations at the Romanian littoral of the Black Sea in summer 2007 and compared to data from 10 samples collected from surface waters (0 m) at Portita in 1973. In 2007, there were 22 holoplanktonic species and 4 benthic larvae identified: 53.85% of all species were marine and the rest were limnic organisms brought by the Danube. In 1973, there were recorded species such as *Anomalocera patersoni*, *Centropages kroyeri* var. *pontica*, which have become extinct or very rare nowadays.
Keywords: Black Sea, Zooplankton , Biodiversity, Density, Biomass

The chronic blooming of phytoplankton due to eutrophication led to an increase in the concentration of particulate organic matter (POM) in the water column and sediments, and implicitly to a phenomena of oxygen depletion or hypoxia [1], [2]. A number of 22 quantitative samples of zooplankton were studied; the samples were collected in late summer 2007 (29.08.-01.09.2007) from standard horizons in 10 stations located in four areas at the Romanian littoral: near the mouths of Danube river at Sf. Gheorghe (Φ=44º52', Λ=29º38'; Φ=44º51', Λ=29º42'; Φ=44º50', Λ=29º47'), then southward at Portita (Φ=44º38', Λ=29º04'; Φ=44º36', Λ=29º08'; Φ=44º33', Λ=29º14'), Midia (Φ=44º21', Λ=28º42'; Φ=44º19', Λ=28º47'; Φ=44º18', Λ=28º49') and Tuzla (Φ=44º00', Λ=28º57'). The sampling was performed with a vertical-tow net made of silk tissue with a 90µm mesh. In 1973, there were 10 samples collected from the surface (0m), by filtering 100l of water through the same type of net. The quantitative data relate to $1m^3$ ($D_{density}$= number of individuals for one cubic metre of water - ind·m^{-3}, $B_{biomass}$=mg·m^{-3}).
In the late summer of 2007, the zooplankton quantity varied from 41 ind•m^{-3} and 1.30 mg·m^{-3} (Midia area, station 8, horizon 25-10 m) to 12505 ind•m^{-3} and 82.49 mg•m^{-3} (Portita area, station 4, horizon 15-10 m); a maximum quantity was based on the weight of Bivalvia larvae (53%), as well as the fresh water rotifers (24%). The number of eudominant species (F -75,1-100%) is large (*N. scintilans*, larvae of Polychaeta, Bivalvia and *Balanus*), with only one copepod, *Acartia clausi*, found among them (table 1).

Tab. 1. The qualitative and quantitative structure of zooplankton in the Black Sea shallow waters along the Romanian shore in 2007 (D%=dominance. F% =frequency. W= ecological significance index. R=rank)

Species	Sf. Gheorghe area				Portita area				Midia area				Tuzla area			
	D%	F%	W	R	D%	F%	W	R	D%	F%	W	R	D%	F%	W	R
Noctiluca scintilans	13	100	13	3	7.3	100	7.3	4	2.4	100	2.4	6	7.9	100	7.9	6
Favella ehrenbergi	1.2	75	0.9	9	0.5	83	0.4	11	1.1	80	0.9	9	22	100	22	1
Beroe ovata	0.8	88	0.7	10	0.4	50	0.2	14	38	20	7.6	4	0	0	0	0
Rotaria citrina	1.4	50	0.7	11	3.1	33	1	9	0	0	0	0	0	0	0	0
Brachionus quadridentatus	0	0	0	0	0	0	0	0	0.1	20	0	14	0	0	0	0
Brachionus calciflorus	0.1	25	0	18	0	0	0	0	0	0	0	0	0	0	0	0
Brachionus angularis	0	13	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Brachionus diversicomis	0	13	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Eosphora thoa	1.8	88	1.6	7	2.3	83	1.9	8	0	20	0	15	0	67	0	11
Polyarthra vulgaris	0.7	25	0.2	15	0.8	50	0.4	12	0	20	0	15	0	0	0	0
Synchaeta littoralis	18	88	16	2	18	100	18	2	1.9	60	1.1	10	14	100	14	3
Larvae Polychaeta	1.2	100	1.2	8	4.8	100	4.8	5	8.4	100	8.4	3	2.6	100	2.6	7
Larvae Gasteropoda	0.7	63	0.4	12	0.7	67	0.4	10	0.3	40	0.1	13	0.4	33	0.1	10
Larvae Bivalvia	45	100	45	1	38	100	38	1	2.6	100	2.6	5	13	100	13	4
Larvae *Balanus*	3.1	100	3.1	5	4.1	100	4.1	6	1.4	60	0.9	9	11	100	11	5
Penilia avirostris	2	88	1.8	6	3.3	83	2.7	7	14	80	11	2	3.1	67	2	8
Bosmina longirostris	0.3	13	0	17	0	0	0	0	0	0	0	0	0	0	0	0
Chydorus sphaericus	0	13	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Pleopis polyphemoides	0	13	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Calanus helgolandicus	0	0	0	0	0	17	0	16	0	0	0	0	0	0	0	0
Acartia clausi	9.8	100	9.8	4	16	100	16	3	25	100	25	1	21	100	21	2
Calanipeda aquae-dulcis	0.2	25	0	16	0	0	0	0	0	0	0	0	0	0	0	0
Eurytemora affinis	0	0	0	0	0	0	0	0	1.6	20	0.3	12	0	0	0	0
Cyclops vicinus	0.1	13	0	19	0	0	0	0	0	0	0	0	0	0	0	0
Oikopleura dioica	0.7	50	0.3	13	0.3	50	0.1	12	1	40	0.4	11	0.4	33	0.1	10
Sagitta setosa	0.3	75	0.3	14	0.3	83	0.3	13	2.3	60	1.4	7	1.8	67	1.2	9

In 2007, a number of 8 species of rotifers were identified (representing 31% of total found species), where only one is a marine species (*Synchaeta littoralis*), and the rest are limnic, also tolerating lower concentrations of oxygen (*Rotaria citrina, Brachionus* sp., *Eosphora ehrenbergi*, *Polyarthra vulgaris*). The crustaceans were represented by 4 species of Cladocera and 5 species of Copepoda, most of them eurihaline and euryoxyc species that usually live in fresh waters (like the cladocers *Bosmina longirostris* and *Chydorus sphaericus*, and copepods such as *Calanipeda aquae-dulcis*, *Eurytemora affinis* and *Cyclops vicinus*).
By comparing the data from 2007 and before 1970 when the eutrophication began [1], we observed that the biomass of the zooplankton was 3.7 times lower due to a decrease in numbers of the copepods. The density is higher as the light-weighted *Noctiluca* and rotifers numbers increase. The value of average density in 2007 was four times lower than in 1973, when the copepods held the major weight among eudominant species (*Acartia clausi* – registered a density of 6617 ind•m^{-3}, and a biomass of 17.38 mg·m^{-3} in July, followed by *Oithona nana*, *Centropages kroyeri* var. *ponticus* and *Paracalanus parvus*) (table 2). In 1973, only one fresh water species (*Calanipeda aquae-dulcis*) was found. In summer months, there were records of thermophilic copepods such as *Centropages kroyeri* var. *ponticus*, *Anomalocera patersoni* and *Oithona nana*, which were
not to be found again in 2007.

Tab. 2. The qualitative and quantitative structure of the zooplankton in the Black Sea shallow waters on Portita transect in 1973 (D_{eco}=ecological average. D%=dominance. F%=frequency. W= ecological significance index. R=rank)

Species	July					September				
	D_{eco}	D%	F%	W	R	D_{eco}	D%	F%	W	R
Noctiluca scintillans	2	0	25	0	12	1	0	60	0	15
Tintinnopsis campanula	0	0	0	0	0	27	0.3	60	0.2	9
Coxliella helix	2	0	13	0	12	68	0.8	100	0.8	7
Metacylis mediterranea	3	0	13	0	12	301	3.4	40	1.4	5
Synchaeta littoralis	15	0.2	50	0.1	8	9	0.1	20	0	13
Larvae Polichaeta	9	0.1	63	0.1	9	15	0.2	80	0.1	10
Larvae Gasteropoda	33	0.4	100	0.4	7	20	0.2	60	0.1	10
Larvae Bivalvia	793	9.3	88	8.1	3	397	4.5	100	4.5	3
Larvae *Balanus*	70	0.8	100	0.8	5	15	0.2	80	0.1	10
Penilia avirostris	2	0	25	0	12	54	0.6	100	0	14
Pseudevadne tergestina	0	0	0	0	0	1	0	40	0	15
Evadne spinifera	2	0	38	0	12	1	0	20	0	15
Pleopis polyphemoides	153	1.8	100	1.8	4	17	0.2	60	0.1	11
Anomalocera patersoni	1	0	13	0	15	0	0	0	0	0
Paracalanus parvus	0	0	0	0	0	278	3.1	100	3.1	4
Acartia clausi	6617	78	100	78	1	2199	25	100	25	2
Centropages kroyeri var. pontica	38	0.4	100	0.4	6	106	1.2	100	1.2	6
Calanipeda aquae-dulcis	7	0.1	50	0	10	0	0	0	0	0
Oithona nana	755	8.9	100	8.9	2	5346	60	100	60	1
Oithona similis	0	0	0	0	0	4	0	20	0	15
Oikopleura dioica	8	0.1	50	0	10	44	0.5	100	0.5	8
Sagitta setosa	4	0	75	0	11	9	0.1	100	0.1	12

;

We may conclude that the modification of environmental variables in the water column led to a decrease in the species diversity of zooplankton, an increase in the weight of euryoxyc limnic species, both small and light sizes. It must be outlined the fact that the high density of bivalves larvae recorded in 2007 in the North sector (1337 ind•m^{-3}) indicates the revitalisation of endopsamic mollusc populations in the area.

References
1 - Onciu T.M., Skolka M. and Gomoiu M.-T., 2006. Ecology of zooplanktonic communities in the Black Sea (in Romanian). Ovidius University Press, Constanta: 150.
2 - Zaitsev Yu.P. and Mamaev V., 1997. Biological Diversity in the Black Sea. A study of change and decline. United Nations Publications, New York: 208.

CONSIDERATIONS REGARDING THE FREE-LIVING MARINE NEMATODA IN THE NORTHERN AREA OF THE ROMANIAN BLACK SEA COAST

Teodora maria Onciu [1]*, Ciprian Samoila [1] and Mihaela Muresan [1]
[1] Ovidius University Constanta - tmonciu@univ-ovidius.ro

Abstract
From seven quantitative samples performed in the northern area of the Romanian coast of the Black Sea, 38 species of free-living Nematoda were determined. Thus, the species richness of observed Nematoda at the Romanian Black Sea coast increased of eight species (*Enoploides brevis, E. hirsutus, Chromadorella pontica, Paramonhystera elliptica, Theristus littoralis, Terschellingia pontica, Sphaerolaimus gracilis, Sphaerocephalum crassicauda*).
Keywords: Zoobenthos, Black Sea, Biodiversity

Introduction
The scientific literature concerning Nematoda at the Romanian Black Sea coast are quite poor and each paper presents some species that were not described before in the studied area [1-6].

Material and Methods
The present paper is based on a research study where Nematoda species were identified from seven quantitative samples. In the period May-July 2003, the samples were obtained by collecting 100 cm^2 of sediment at different depths (3m, 5m, 15m, and 20m) in the northern part of the Romanian Black Sea Coast, between Sf. Gheorghe (near the mouths of the Danube) and Mamaia, on sedimentary (mud and fine sand) sea bottom.

Tab. 1. The qualitative and quantitative structure (D= ind·m^{-2}) of the free-living marine nematoda in the northern area of the Black Sea in 2003

Species	Sf. Gheorghe area	Mamaia area
Enoplus quadridentatus Berlin, 1853	3600	2100
Enoplus littoralis Filipjev, 1918	33200	7200
Enoploides brevis Filipjev, 1918	15200	0
Enoploides hirsutus Filipjev, 1918	2400	0
Viscosia cobbi Filipjev, 1918	12000	400
Viscosia minor Filipjev, 1918	1600	2600
Viscosia glabra Bastian, 1865	800	0
Oncholaimus dujardini de Man, 1868	12000	600
Oncholaimus campylocercoides C. et Schu.-Stekh., 1993	32000	16600
Metoncholaimus demani zur Strassen,1894	3200	0
Anoplostoma viviparum Bastian, 1865	9000	0
Sabatieria clavicauda Filipjev, 1918	77200	0
Sabatieria longicaudata Filipjev, 1922	1600	0
Cyatholaimus gracilis (Eberth, 1863) Bastian, 1865	0	1300
Halichoanolaimus clavicauda Filipjev, 1918	21200	5200
Chromadora nudicapitata Bastian, 1865	7000	11200
Euchromadora striata Eberth, 1863	0	1400
Chromadorella pontica Filipjev, 1922	14000	0
Paramonhystera elliptica Filipjev, 1918	0	15000
Penzacia euxina Filipjev, 1918	6000	0
Theristus setosus Bütschli, 1874	800	0
Theristus maeoticus Filipjev, 1922	800	119900
Theristus longicaudatus Filipjev, 1922	1600	12800
Theristus littoralis Filipjev, 1922	800	38400
Theristus latissimus Filipjev, 1922	30000	2300
Linhomoeus hirsutus Bastian, 1865	6800	0
Disconema alaima Filipjev, 1918	0	400
Terschellingia pontica Filipjev, 1918	0	3600
Terschellingia longicaudata de Man, 1907	800	0
Prosphaerolaimus eurypharinx Filipjev, 1918	0	800
Sphaerolaimus gracilis de Man, 1884	2400	0
Sphaerolaimus dispar Filipjev, 1918	23000	800
Sphaerocephalum crassicauda Filipjev, 1918	0	6000
Odontophora angustilaima Filipjev, 1918	0	6400
Axonolaimus setosus Filipjev, 1918	0	1200
Axonolaimus ponticus Filipjev, 1918	0	2400
Bathylaimus assimilis de Man, 1922	6000	4300
Bathylaimus cobbi Filipjev, 1922	800	2800

The density data is expressed as number of individuals per 1 square meter (D= ind·m^{-2}). A total of 38 species of free-living Nematoda were determined (table 1).

Results and Discussion
The determined species belong to four orders (Enoplida, Chromadorida, Monhysterida and Areolaimida), respectively 11 families (Enoplidae, Oncholaimidae, Comesomatidae, Cyatholaimidae, Choanolaimidae, Chromadoridae, Monhysteridae, Linhomoeidae, Sphaerolaimidae, Axonolaimidae and Tripyloididae). Among them, the families Oncholaimidae and Monhysteridae include seven species each, followed by Linhomoeidae with five species and Enoplidae and Axonolaimidae with four species each. Eight of the total number of observed species (*Enoploides brevis, E. hirsutus, Chromadorella pontica, Paramonhystera elliptica, Theristus littoralis, Terschellingia pontica, Sphaerolaimus gracilis, Sphaerocephalum crassicauda*) proved to be new records at the Romanian coast of the Black Sea. The species diversity of Nematoda living on muddy substrata (Sf. Gheorghe area)(28 species) and their density (between 800 ind·m^{-2} and 77 200 ind·m^{-2}) are remarkable. Ten species (35,7 %) have densities which reach over 10 000 ind·m^{-2}. In the area of Mamaia resort, there were found only 24 species on fine sand bottom. Their density varies between 400 ind·m^{-2} and 119 900 ind·m^{-2}, the density of six species (25,0 %) reaching values greater than 10 000 ind·m^{-2}. The densities of *Theristus littoralis* (38 400 ind·m^{-2}) and of *Th. maeoticus* (119 900 ind·m^{-2}) were particularly high. Sixteen species are ubiquitous (*Enoplus quadridentatus, E. littoralis, Viscosia cobbi, V. minor, Oncholaimus dujardini, O. campylocercoides, Sabatieria clavicauda, Halichoanolaimus clavicauda, Chromadora nudicapitata, Theristus maeoticus, Th. longicaudatus, Th. littoralis, Th. latissimus, Sphaerolaimus dispar, Bathylaimus assimilis, B.cobbi*) and are present in each zone sampled. In terms of values of density, the representative species of free living Nematoda for the sedimentary zone in the North area of the Romanian Black Sea coast are *Sabatieira clavicauda* and *Theristus maeoticus*. In terms of values of density, the representative species of free living Nematoda for the sedimentary zone in the North area of the Romanian Black Sea coast are *Theristus maeoticus* (dominance = 20,41%, index of ecological significance = 34,15) followed by *Sabatieria clavicauda* (dominance = 13,05%, index of ecological significance = 19,31) and *Metaparoncholaimus campylocercoides* (dominance = 8,22%, index of ecological significance = 28,66).
In conclusion, the list of free-living marine Nematoda at the Romanian coast of the Black Sea has reached a number of 91 species, now including the new eight species recorded in the Northern area in 2003.

References
1 - Groza-Rojankovski E., 1972. Free-living marine Nematodes from the Black Sea. *Revue Roumaine de Biologie*. Ser. Zool., 17: 201-212.
2 - Groza-Rojankovski E., 1975. About free-living Nematoda from the *Phyllophora* Belt from the Black Sea and some data concerning the species *Sphaerocephalum chabaudi* Inglis,1962 (in Romanian). *Trav. Mus d´Hist. Nat. "Gr. Antipa"*, 17**:** 21-25.
3 - Paladian G., 1965a. Donneés sur les Nematodes de benthos profond de la Mer Noire (Littoral roumain). *Proc. Verb. des reun. de la Mer Noire*, 17: 267-271.
4 - Paladian G., 1965b. Some Chromadorides (free-living Nematode) from the rocky facies of the Black Sea. *Trav. Mus d´Hist. Nat."Gr. Antipa"*, 5: 167-173.
5 - Onciu T.M., 1972. Contribution à l´ étude des Nématodes libres du littoral roumain de la mer Noire. *Recherches Marines* Constanta, 3: 75-93.
6 - Tiganus V., Onciu T. and Aonofriesei F., 1998. Données préliminaires sur les organismes en proximite des sources sous-marines sulfureuses du littoral roumain de la mer Noire. *Rapp Comm. Int .Mer Médit.***,** 35**:** 492-494.

DISTRIBUTION AND ABUNDANCE OF SARDINE AND ANCHOVY LARVAE IN THE EASTERN MEDITERRANEAN SEA

Isik K. Oray [1]*, Ibrahim Tamer Emecan [2] and Didem Göktürk [3]
[1] Cyprus Marine Science Foundation - isikoray@yahoo.com
[2] Istanbul University, Vocational School of Technical Sciences, Underwater Technology
[3] Istanbul University, Faculty of Fisheries

Abstract
The distribution, abundance and size structure of sardine and anchovy larvae were collected in the northern Levantine Sea (eastern Mediterranean) in an ichthyoplankton survey between 5-18 June 2004. Sardine and anchovy larvae showed a wide distribution off the Turkish continental shelf. Especially Mersin Bay was an important spawning area in the northern Levantine Sea.
Keywords: Ichthyoplankton, Fishes, Pelagic, Larvae, Eastern Mediterranean

Introduction

Anchovy, *Engraulis encrasicolus* (Linnaeus, 1758), one of the most import pelagic species of the Turkish fishery taking the first place with 385000 tons/year, and sardines, *Sardina pilchardus* (Walbaum, 1792), with 21000 tons/year ranges third after the Atlantic horse mackerel [1]. Anchovy are caught mostly in the Black Sea. The sardine catch is concentrated mainly in the Aegean Sea. 13.7% of the total sardine and 0.04% of anchovy catch comes from the northern Levantine Sea. Research has been carried on the distribution of the eggs and larvae of anchovy and sardine in the Marmara, Aegean and Black Seas ([2], [3]) but no investigations was done on these important pelagic species in the eastern Mediterranean Sea. The aim of this paper is to give the results of larval research on the distribution and abundance of the sardine and anchovy larvae in the northern Levantine Sea.

Material and Methods

The ichthyoplankton samples were collected in the TUNALEV survey on board of the Turkish trawler 'Emicaoglu' from 05-18 June 2004 in the northern Levantine Sea (Fig. 1).

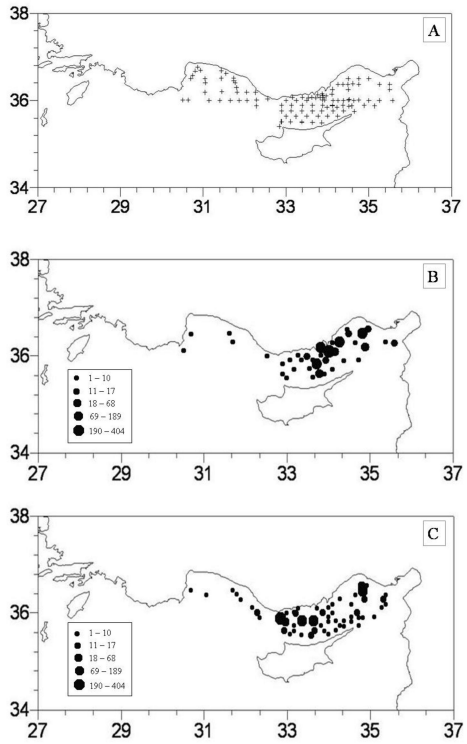


Fig. 1. A) Map of the study area, B) Distribution and abundance of sardine larvae (larvae/1000m^3), C) Distribution and abundance of anchovy larvae (larvae/1000 m^3)

A total of 104 sub-surface plankton horizontal tows with a Bongo 90 cm of quadrangular mouth opening with a 1 mm mesh for horizontal surface tows and a Bongo net of 60 cm inlet diameter equipped with 250 µm mesh for oblique tows were made. The distance between each station was chosen as 10-15 nautical miles. All tows were fixed at 10 minutes duration. The collected ichthyoplankton material was then preserved in 5% neutralized formalin.

Results and Discussion

During the ichthyoplankton survey, the sea water temperature was measured as 21.8– 29.3°C, where by the salt content varied between 34.9 – 38.8‰, the water depth being 63-2448 m. In this larval survey, 1779 larvae of *Sardina pilchardus* and 744 *Engraulis encrasicolus* were collected. Fig. 1B-C shows the distribution of sardine and anchovy larvae. High abundance of these fish larvae was observed in the Cilician Basin, between Turkey and northern Cyprus and in Mersin Bay. The larvae of these fish species were observed in very small numbers in Antalya Bay.

During the larval survey; ichthyoplankton was sampled in 104 stations. The sardine larvae were collected in 39 stations where by the 10-14 mm SL larvae comprised 65% of the sardine individuals. The length of the sardine larvae was 4.0 – 22.0 mm SL, the medium length being 12.4 ± 0.06 (SE) mm. The anchovy larvae were found in 58 stations. The 10-14 mm SL individuals comprised 55.5% of the anchovy larvae. The length of the anchovy larvae was 4.0 – 22.0 mm SL, the medium length being 12.2 ± 0.12 (SE) mm.The sardine and anchovy larvae were distributed in a wide area. The water depth of the sampled stations, where sardines were collected was 80-1170 m. The anchovy larvae were observed at sampling stations in water depths of 60-2000 m. The sardine and anchovy larvae were abundant in shelf. The number of the larvae decreased in off shore areas. According to Murua and Saborido-Rey [4], the reproduction of sardine occurs in the open sea or in the shelf areas. The presence of larvae in our research deeper than 1000 m could possibly be related to advection by sea currents in the study area.

In the previous papers, the distribution and abundance of the tunas (large pelagic species) in Mersin Bay, *Thunnus thynnus*, *Thunnus alalunga*, *Auxis rochei*, *Euthynnus alletteratus*, *Scomber scombrus*, *Scomber japonicus*, *Katsuwonus pelamis* have been reported [5]. The results of this survey confirm that Mersin Bay is an also spawning ground of small pelagic fish; namely of sardine and anchovy.

This important spawning ground should stay under protection. Excessive fishing should not be exercised. Pollution and introduction of energy sources leading to ecological changes in Mersin Bay should be avoided. Renewable energy such as solar, and wind energy should be preferred.

References

1 - TUIK., 2007. Fisheries Statistics 2007.Turkish Statistical Institute, 48 p., Ankara.

2 - Mater, S., 1981. Effects of Pollution on Abundance and Distribution of Teleost Fishes Eggs in Izmir Bay (Aegean Sea, Turkey). *Rapp. Comm. Int. Mer. Médit*., 27, 5:147-150.

3 - Cihangir, B., 1991. Ege Denizi Izmir Körfezi'nde 1989-1990 üreme döneminde sardalya baligi *Sardina pilchardus* (Wal., 1792)'un yumurtalarinin bolluk ve dagilimi. *J. of Zoology* 19:17-26.

4 - Murua, H., Saborido-Rey, F., 2003 Female reproductive strategies of marine fish species of the North Atlantic. *J.Northwest Atl.Fish.Sci*.33:23-31.

5 - Oray, I. K., Karakulak, F. S., 2005. Further evidence of spawning of bluefin tuna (*Thunnus thynnus thynnus* L., 1758) and the tuna species (*Auxis rochei* Ris., 1810, *Euthynnus alletteratus* Raf., 1810) in the eastern Mediterranean Sea:preliminary results of TUNALEV larval survey in 2004. *J. Appl.I chthyol*. 21, 236–240.

ASSESSMENT OF THE ECOLOGICAL STATUS OF SLOVENIAN COASTAL WATERS WITH MACROBENTHIC BIOLOGICAL ELEMENTS

Martina Orlando-bonaca [1]*, Borut Mavric [1] and Lovrenc Lipej [1]
[1] Marine Biology Station, National Institute of Biology - orlando@mbss.org

Abstract
Benthic macrophytes on hard bottom and soft-botom invertebrates are two important biological elements for the assessment of the ecological status (ES) in coastal waters, according to the European Water Framework Directive (WFD, 2000/60/EC). The aim of the study is to verify whether the monitoring results reconfirm the preliminary evaluation of the ES according to these biological elements. The ES was reconfirmed as *Good*.
Keywords: Monitoring, Coastal Waters, Biodiversity, Bio-Indicators, Adriatic Sea

Introduction
The results of a preliminary assessment of benthic macroalgae in Slovenian coastal waters [1], according to the WFD, led to a selection of 7 sampling sites on hard bottom for the surveillance monitoring programme. In the same way, a preliminary assessment of benthic invertebrates led to a selection of 6 sampling sites on soft bottom. The aim of the study was to verify whether the results of the first two years of monitoring programme confirm the preliminary assessment of benthic elements or indicate different conditions/situation of these organisms in Slovenian coastal waters.

Material and Methods
The Slovenian coastal sea covers the southern part of the Gulf of Trieste. Its coastline is approximately 46.7 km long. It is a shallow semi-enclosed gulf with a maximum depth of ca. 33 m in waters off Piran. During 2007 and 2008, benthic macroalgae were sampled in three water bodies (WB): SI5VT3, SI5VT4 and SI5VT5, while benthic invertebrates were sampled only in two WB: SI5VT3 and SI5VT5. SI5VT4 was characterised as "rocky shallow moderately exposed", while the other two (SI5VT3, SI5VT5) as "sedimentary shallow moderately exposed". All sites were sampled twice: in spring and in late summer. Macroalgae were sampled and their status assessed according to the national methodology, which includes the use of EEI (Ecological Evaluation Index) [2]. Samples of benthic invertebrates were collected and assessed according to the national methodology [3] using *M-AMBI*(Multivariat Azti Marine Biotic Index) [4, 5].

Results and Discussion
During the 2007-2008 period, 5 sampling sites for macroalgae were evaluated as *High*, one as *Good* and one as *Poor* ES. After the application of the spatial scale weighted EEI, the WBs ES was evaluated as *High* in SI5VT4 and as *Good* in SI5VT5, which reconfirm those from the preliminary study [1]. The macroalgae monitoring revealed seasonal differences in species composition and coverage. At almost all sites, the ES was higher in summer then in spring. The ES evaluation of benthic invertebrates in 2007 and 2008 classified both SI5VT3 and SI5VT5 as *Good* ES, which is in accordance with the preliminary ES evaluation. In both years the situation was better in late summer. There are slight discrepancies in the Ecological Quality Ratios (EQRs) for SI5VT3. The overall EQR value for both monitoring years lies on the border between Good and Moderate class (0.62), while in the preliminary study, the EQR value lies in the middle of the EQR range for Good class (0.70). The results of the assessment from 2006 to 2008 show a Good ES of Slovenian coastal waters. Further samplings and studies need to be carried out in order to rise confidence of the obtained results and applied methods.

References
1 - Orlando-Bonaca M., Lipej L. and Orfanidis S., 2008. Benthic macrophytes as a tool for delineating, monitoring and assessing ecological status: the case of Slovenian coastal waters. *Marine Pollution Bulletin* 56(4): 666-676.
2 - Orfanidis S., Panayotidis P. and Stamatis N., 2001. Ecological evaluation of transitional and coastal waters: A marine benthic macrophytes-based model. *Mediterranean Marine Science* 2(2): 45-65 .
3 - GIG., 2008. WFD intercalibration technical report. Part 3-Coastal and Transitional Waters.Sect 2 – Benthic invertebrates. http://circa.europa.eu/Public/irc/jrc/jrc_eewai/library.
4 - Muxika I., Borja A. and Bald J., 2006. Using historical data, expert judgment and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European Water Framework Directive. *Marine Pollution Bulletin* 55: 16-29.
5 - http://www.azti.es v.4

MEDUSIVOROUS FISHES OF THE LIGURIAN SEA 1. CHUB MACKERELS AND OTHER PELAGIC FISH SPECIES SOMETIMES "HAVE THE MEDUSA" *PELAGIA NOCTILUCA*

Lidia Orsi Relini [1]*, Fulvio Garibaldi [1], Luca Lanteri [1] and Marco Relini [1]
[1] Centro di Biologia Marina del Mar Ligure, University of Genoa - largepel@unige.it

Abstract
During blooms of *Pelagia noctiluca* periodically occurring in the Ligurian Sea (North Western Mediterranean), a natural mark, formed by the jellyfish pigments, characterizes fish eating this species.
Keywords: Western Mediterranean, Medusae, Pigments, Fishes

CIESM is promoting observations about gelatinous zooplankton blooms, in particular those of jellyfish, which may be related to basic transformations of ecosystems, both of climatic and anthropogenic nature (1, 2). Such renewed attention to medusozoans has the consequence that parallel studies should be carried out about the consume of jellyfish by many marine organisms (3), particularly the most abundant fishes (4, 5); in fact if fishing or other anthropic activities are mentioned among possible causes of jellyfish blooms (2), it is necessary to know the trophic relationship among the concerned organisms.

Worldwide studies about medusivorous fish (3, 4, 5) allow us to list the following species which are also part of Mediterranean ichthyofauna, with indication in parenthesis, of the area in which the jellyfish consume was observed: *Squalus acanthias* (North Sea), *Etmopterus spinax* (North Atlantic), *Centroscymnus coelolepis* (North Atlantic), *Alepocephalus rostratus* (South Atlantic, Mediterranean sea), *Scomberesox saurus* (North Atlantic), *Boops boops* (Gulf of Tunis), *Trachurus trachurus* (North Sea), *Coryphaena hippurus* (Mediterranean Sea),

Sparus aurata (New Zealand waters), *Scomber colias* (Japanese waters), *Scomber scombrus* (Baltic Sea, North Sea, Western North Atlantic), *Luvarus imperialis* (Eastern North Atlantic), *Centrolophus niger* (Mediterranean Sea), *Hyperoglyphe perciformis* (Gulf of Maine), *Schedophilus medusophagus* (Mediterranean Sea, North Atlantic), *Stromateus fiatola* (Mediterranean Sea), *Mola mola* (North Atlantic, Japanese waters, Gulf of Maine, North Pacific), *Ranzania laevis* (North Atlantic). Only in few cases the consume of jellyfish have been observed in the Mediterranean; in particular the observations regarding Mediterranean stromateoid fishes occurred in Italian waters more than one century ago, thanks to Anastasio Cocco and Salvatore Lo Bianco.

All the listed fish species are present in the Ligurian Sea, an area of recognized richness of pelagic life (6), including offshore and coastal protected areas, such as the Cetacean Sanctuary and Portofino MPA, both SPAMI under the Barcelona convention. During recent blooms of *Pelagia noctiluca* we have ascertained its consume by four species of fish, three of them already known as medusivorous, i.e. *S. colias*, *T. trachurus* and *S. medusophagus* (7) and one, *Oblada melanura*, representing a new entry in the group. With regard to prey, *P. noctiluca* is well known in our study area. On the basis of impact on anthropic activities, organized research (frequently on international basis), assembled knowledge (but not all life cycle is exhaustively known), *P. noctiluca* can be placed in the top six jellyfish species of the world (8). Fluctuations of abundance of *P. noctiluca* in the Ligurian Sea have been studied assembling 200 years of Mediterranean records (9). A twelve years periodicity was found, each period being formed by groups of years with and without blooms of this species. Using a forecasting model, climatic variables, notably temperature, rainfall and atmospheric pressure appeared to predict years with *Pelagia*.

P. noctiluca has an olopelagic life history: a large egg (0.3 mm) gives rise to larval forms (*ephyrulae*) which in three months become young *medusae* (8). The nice pink-lilac colour of *P. noctiluca* is due to four different pigments, a brown, a magenta and two blue substances, distributed with sexual dichromism in mature individuals (8). When fish eat large quantities of *P. noctiluca*, pigments and/or their indigested residues reach a great concentration in the gut colouring the entire intestinal tract, to the anus (7).

During the most recent blooms (from 2006 onward), *Scomber colias*, *Trachurus trachurus*, *Oblada melanura* arrived to the market with the mark of *P. noctiluca*, that is presenting the anal rim surrounded by a violet blot (fig. 1). This fact brought to a popular level the knowledge of jellyfish consume: asked for the reason of such colour, fishermen and retailers simply answer that the fish "has the medusa".

In conclusion: 1) consume of jellyfish is not easily studied, given the fragility of tissues and the necessity to look for specific structures such as nematocysts at the microscope. In the case of *Pelagia* probably a relevant part of predation occurs on larvae and goes unnoticed. But when the stage of medusa is reached and aggregations are forming, studies on consumers are made easier by the natural mark; 2) chub and horse mackerels are able to use large quantities of *P. noctiluca*, because of their massive presence. In fact these species are in a growing phase since at least ten years (10); 3) in healthy pelagic ecosystems (the Ligurian Sea has a very important presence of top predators and a reduced fishery pressure), global warming is probably enhancing the presence of some jellyfish species and of their consumers as well, maybe building new balances.



Fig. 1. Gut content coloured by *Pelagia noctiluca* pigments in the chub mackerel *Scomber colias* (photo by Giulio Relini)

References
1 - Mills C.E., 2001. Jellyfish blooms: are populations increasing globally in response to changing ocean conditions? *Hydrobiol.*, 451: 55-68.

2 - Purcell J. E., Uye S-i and Lo W-T., 2007. Anthropogenic causes of jellyfish blooms and their direct consequences for humans: a review. *Mar. Ecol. Progr. Ser.*, 350: 153-174.

3 - Arai M.N., 2005. Predation on pelagic coelenterates: a review. *J. Mar. Biol. Ass. U.K.*, 85: 523-536.

4 - Ates R.M.L., 1988. Medusivorous fishes, a review. *Zool. Meded*., 62: 29-42.

5 - Arai M.N., 1988. Interactions of fish and pelagic coelenterates. *Can. J. Zool.*, 66: 1913-1927.

6 - Relini G. (ed.), 2007. The pelagic domain. Pelagos the whale Sanctuary. *Italian habitats. Min. Environment Terr. Protection*, 16, pp. 156. Available online at Friuli M.N.H. http://www.comune.udine.it/

7 - Garibaldi F. and Orsi Relini L., 2010. Medusivorous fishes of the Ligurian Sea 2. The specialist, *Schedophilus medusophagus*. *Rapp. Comm. int. Mer Médit.*

8 - Goy J. and Toulemont A., 1997. Meduses. *Collection Abysses n. 5, Musée océanographique de Monaco*, pp. 159.

9 - Goy J., Morand P. and Etienne M., 1989. Long-term fluctuations of *Pelagia noctiluca* (Cnidaria, Scyphomedusa) in the western Mediterranean Sea. Prediction by climatic variables. *Deep-Sea Res.*, 36 (2): 269-279.

10 - Relini M., 2001. Changes in a north western Mediterranean fish coastal assemblage on the basis of the catches of the Camogli tuna trap. *Rapp. Comm. int. Mer Médit.*, 36: 314.

MEDUSIVOROUS FISHES OF THE LIGURIAN SEA 3. THE YOUNG GIANT, *MOLA MOLA* AT THE CAMOGLI TUNA TRAP

Lidia Orsi Relini [1]*, Giovanni Palandri [1] and Marco Relini [1]
[1] Centro di Biologia Marina del Mar Ligure, University of Genoa - largepel@unige.it

Abstract
The fishery of *Mola mola* occurred in the Ligurian Sea from ancient times to the end of the '90s when the use of *M. mola* as food was banned by the European Community. *M. Mola* was fished at the small artisanal tuna trap of Camogli, a very ancient gear at present located in the Portofino MPA. We used literature data (commercial product in the periods: 1950-1974, 1996-2000) and original unpublished data size structures per month (1993-1995; fillets/fish ratio) to estimate numbers of fish caught during the past exploitation. These were very young fish whose utilization can be traced at least one century ago. The Camogli tuna trap has allowed the monitoring, albeit in relatively short time periods, of the abundance of seven species of regular (*M. mola*) or potential medusivorous fish.
Keywords: Western Mediterranean, Fisheries, Coastal Waters

Among medusivorous fish (1), the sunfish *Mola mola* (Linnaeus, 1758) is classified in the group of species which feed only on jellyfish or use a prevailing quantity of this prey; the latter category seems the most appropriate for *M. mola*. The use of gelatinous macroplankton allows fast growth and the attainment of the most relevant size among living bony fish; a parallel case can be found in the marine turtles, with *Dermochelys coriacea*. In the last ten years, these characteristics have promoted a renewed interest to *M. mola* and the development of new research lines, especially based on archival tags and satellite tracking: the reason is that "data on what environmental factors influence the abundance and distribution of *M. mola* can also offer additional insight into what may be influencing the availability and blooms of gelatinous prey species" (2). However *M. mola* remains a poorly known species, particularly in the Mediterranean. Reproduction, in terms of times and locations, remains a major gap of its life history (3) and also distribution is scarcely understood. At the best of authors knowledge, *M. mola* results really abundant in few Mediterranean areas: one is located in the Ligurian Sea, at Camogli (western side of Portofino promontory), where fishermen still use an ancient two-chambered artisanal tuna trap (six men crew for hauls). This gear was common about four centuries ago along the Ligurian coast, from Marseille (4) to La Spezia. The trap is active from April to September, with three hauls per day. Until 2000 (5), commercial landings per fishery season resulted about 50 tons, and included more than 40 fish species, with a *Mola* product of about 2 tons, but at present, due to E.C. regulations, this fish cannot be used as food and is released alive. Parona (6), during a local visit in June 1912, recorded more than 500 individuals of *Mola* in the trap and reported that although this fish was part of the commercial product, sometimes its abundance reached numbers considered by fishermen unfavourable for the fishing of bluefin. Total catches of the tuna trap were studied in the '70s (7), thanks to the daily registration of the commercial products carried out from 1950 onward by the same fishermen who were experimenting different kinds of net in the trap chambers. Two form of CPUE (a proxy of fish abundance) were derived: total landings per fishery season and average daily landing of the top ten species in a time series of 25 years, from 1950 to 1974: the species were *Auxis rochei, Boops boops, Sarpa salpa, M. mola, Oblada melanura, Sarda sarda, Scomber japonicus, Scomber scombrus, Scomberesox saurus, Trachurus trachurus* (7). *M. mola* was registered with quantities varying between 0.86 and 5.84 tons per fishery season (164-182 days of fishing). In the study of the fishery trends of the top species *M. mola* resulted one of the most regular (7), uninfluenced by materials used in the gear construction. In the period 1993-1995, thanks to an E.C. funding regarding large pelagic fish, we studied the size structure of the fished stocks by different gears, including the Camogli tuna trap. Observations regarding *M. mola* (an example of l/f distribution is given in fig. 1), that was not a target species, remained unpublished. At present large numbers of fish are observed as at the time of Parona (6), but in absence of fishing, it is impossible to quantify their presence (8). Moreover the quantities registered from 1950 to 2000, don't regard directly the fish, but its commercial form, the fillets. Which is the ratio fish-fillets? From the structure of the fished stock we have obtained the average fish, 45.4 cm total length and about 5 kg weight (9), supposed in the first year of life. This represents the modal size in June that is the core of the fishing season. In this month we have observed the preparation of fillets: an average of 0.82 kg of product per specimen (N=80; range 36-75 TL) that is the 16.4% of the fished biomass. Such data allow to transform the above indicated total catches in number of fish: in the 25 years series the range was about 1000-7100 fishes with an average of 3626 per fishery season and at the end of the '90s the average catch was consisting of about 2436 fishes. We cannot say if this number represent a decrease in respect of the past series because in the years 1950-1960 seven annual catches resulted under this level (7): the indicated time period is not suspected in regard of the other gears which can capture the sunfish i.e. driftnets, which were developed in the '80s. Taking into account the list of Mediterranean medusivorous fish (10), we can observe that the Camogli tuna trap till recent times was permitting the monitoring of seven species of regular and potential medusivorous fish: at present the monitoring of *M. mola* is cancelled as well as an ancient know how regarding the fish and the possibility to offer the sun (in english) or the moon (in italian pesce luna) on the table at Portofino. Given the present relevance of this species for research at ocean scale (2) we suggest to open a debate on this subject.

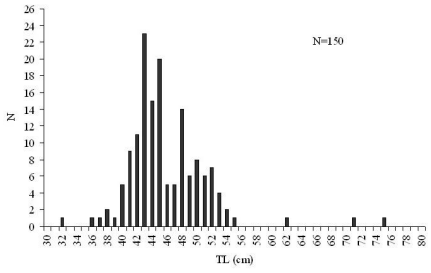


Fig. 1. Length/frequency distribution of *M. mola*, caught by the Camogli tuna trap (sum of hauls carried out in May-July 1993).

References
1 - Ates R.M.L., 1988. Medusivorous fishes, a review. *Zool. Meded*., 62: 29-42.
2 - Thys T., Dewar H., Farwell C., O'Sullivan J., Wang K., Walli A., Teo S., Tobayama T., Soichi M., Kondo Y., Okada Y. and Nakatsubo T., 2007. Tracking the world largest jelly predator, *Mola mola*, in the Eastern and Western Pacific. Second International Symposium on tagging and tracking marine fish with electronic devices, October 8-11, San Sebastian, Spain: 113.
3 - Tortonese E., 1956. Iniomi, Plectognathi in Uova, larve e stadi giovanili di Teleostei. *Fauna Flora Golfo di Napoli*, 38: 979-989.
4 - Mouton, 2004. Le thon de la Méditerranée. Edisud. Aix-en-Provence. pp. 140.
5 - Relini M., 2001. Changes in a north western Mediterranean fish coastal assemblage on the basis of the catches of the Camogli tuna trap. *Rapp. Comm. int. Mer Médit.*, 36: 314.
6 - Parona C., 1919. Il tonno e la sua pesca. *Mem. R. Com. Talass. Ital.*, Venezia, pp. 265.
7 - Balestra V., Boero F. and Carli A., 1976. Andamento del pescato della Tonnarella di Camogli dal 1950 al 1974.. Valutazioni bio-statistiche. *Bollettino di Pesca, Pescicoltura e Idrobiologia*, 31: 105-115.
8 - Cattaneo-Vietti R. and Bava S. (a cura di), 2009. La tonnarella e la pesca tradizionale a Camogli. *Microart's Recco* (Genoa), pp. 143.
9 - Watanabe Y. and Sato K., 2008. Functional Dorsoventral Symmetry in Relation to Lift-Based Swimming in the Ocean Sunfish *Mola mola*. *PLoS ONE* 3 (10): 1-7.
10 - Orsi Relini L., Garibaldi F., Lanteri L., Relini M., 2010. Medusivorous fishes of the Ligurian Sea 1. Chub mackerels and other pelagic fish species sometimes "have the medusa" *Pelagia noctiluca*. *Rapp. Comm. int. Mer Médit.*

SETTING UP AN EGG-DENSITY MODEL FOR EUROPEAN ANCHOVY, *ENGRAULIS ENCRASICOLUS*

Andrés Ospina-álvarez [1] and Isabel Palomera [1]*
[1] Institut de Ciències del Mar (ICM-CSIC) - isabel@icm.csic.es

Abstract

The vertical distribution of pelagic fish eggs is an important issue in modeling and fisheries science. Knowledge on the influence of egg-density is a key aspect in IBM's where satisfactory equations to simulate realistic spatial variation are required. The egg-density of European anchovy is poorly known and only some studies on Atlantic provide information about it. An equation was fitted to describe changes in egg-density across development time. We found that the egg-density of anchovy in the Mediterranean is higher than in Atlantic waters. A functional model suitable for Mediterranean and Atlantic waters was established.

Keywords: Fishes, Density, Ichthyoplankton, Models, Spawning

Introduction

Small pelagic fish populations have a reproductive strategy resulting from past natural selection pressure, which make them adapted to the constant structural instability where they persist [1]. One adaptation is the buoyancy of eggs due to density changes through development [2]. This is an important issue in fisheries and modeling science, because they affect the vertical distribution of eggs, and therefore the transport [3]. The Individual Based Models IBMs that study the transport of fish eggs from spawning to nursery grounds is a novel approach that might be useful to further understand the recruitment variability [4]. In the southern Benguela ecosystem,simulations on the effects of physical and biological variables on the transport of anchovy (*Engraulis capensis*) eggs including a buoyancy model scheme maximize the average particle transport success [3, 5]. Modeling studies that include a fixed value for egg density overestimate the effects of the egg-buoyancy in the transport. However, the density of pelagic fish eggs is not constant and the egg-density changes during development [6, 7]. We fit an equation to describe the egg-density of European anchovy through development. A better knowledge of egg-density could improve the present models of
transport on IBM's.

Materials & Methods

Ichthyoplankton samples from the Gulf of Lions were collected in May–June 2008 survey. The samples were immediately taken to the laboratory onboard. We identified anchovy eggs and their stages; only early stages (I-II) were selected for the experiment. Egg-density measurements were carried out in a Density Gradient Column (DGC) [6]. The eggs were introduced in DGC and their height was measured at intervals until hatch. The height of eggs in DGC is an indication of their density. The DGC was kept at 18.5°C. The total duration of incubation of anchovy eggs varies with temperature; some egg-stages being more or less durable than others. By merging equations (Fig.1) we obtained a polynomial equation (eq.3) to calculate egg-density considering the time from fertilization, the effect of temperature and the spawning and hatching densities. With the resulting equation we built a model (Fig.1c) by comparing the egg-density in the Bay of Biscay [7] and in the Gulf of Lion. Additionally, we include the egg-density model in ICHTHYOP [8] analyzing the
effect of buoyancy in the egg transport.

Results

We found that the egg-density of anchovy in the Mediterranean is higher than in Atlantic waters. However, the curve shape describing the egg-density trough development is the same (Fig. 1c). The main factors influencing the egg-density changes in the model are the seawater densities at spawning and hatching points. The incubation time is determined by the seawater temperature [9]. We found differences in simulated trajectories patterns of anchovy eggs when: 1) egg-density was not considered, 2) a fixed egg-density was included and 3) with a variable egg-density equation.

Discussion

Knowledge on reproductive habitats is a key aspect for management of small pelagic fishes. The IBM's focuses in transport are an important tool for these aspects. However, satisfactory biological equations to simulate realistic spatial variation are required. The egg-density and subsequently buoyancy are poorly known. Some models include the assignation of a fixed value to egg-density and its movements according to Stoke's law. However, we found differences when variable egg-density is considered. In Mediterranean waters the incubation of anchovy eggs during peak spawning is approximately 48 hours, in other words during the first 48 hours of transport the egg-density is influencing the horizontal and vertical trajectories, routes and hatching zones. Additionally, during this time anchovy eggs experience different temperatures, salinities and densities. It is then essential to include an egg-density equation into transport
models to improve the current IBM models.

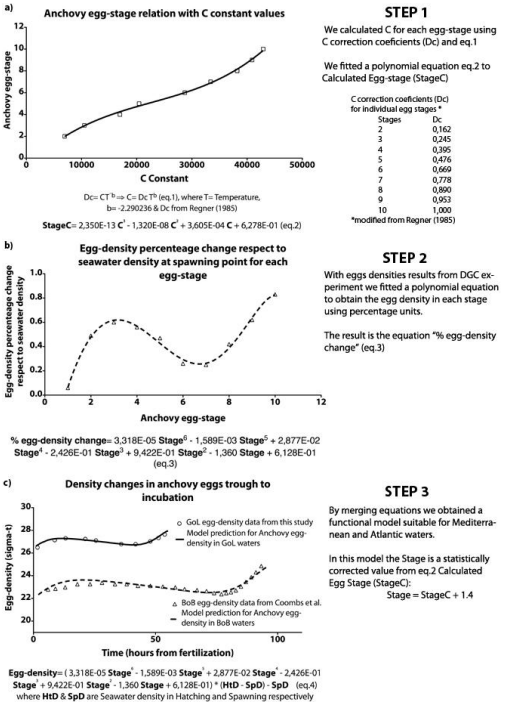


Fig. 1. Steps for the obtention of an anchovy egg-density model

References

1 - Brochier, T., et al., 2009. Small pelagic fish reproductive strategies in upwelling systems: A natal homing evolutionary model to study environmental constraints. Prog Oceanogr .

2 - Tanaka, Y.,1992. *J*apanese anchovy egg accumulation at the sea surface or pycnoclineóobservations and model. *J Oceanogr*, 48(4): p. 461-472.

3 - Petitgas, P., et al., 2006. One-dimensional biophysical modelling of fish egg vertical distributions in shelf seas. *Fisheries Oceanogr*, 15(5): p. 413.

4 - Stenevik, E., et al., 2001. Influence of buoyancy and vertical distribution of sardine Sardinops sagax eggs and larvae on their transport in the northern Benguela ecosystem. *S Afr J Marine Sci*, 23(1): p. 85-97.

5 - Parada, C., et al., 2003. Modelling the effect of buoyancy on the transport of anchovy (Engraulis capensis) eggs from spawning to nursery grounds in the southern Benguela: an IBM approach. *Fish Oceanogr*, 12(3): p. 170-184.

6 - Coombs, S., 1981. A density-gradient column for determining the specific gravity of fish eggs, with particular reference to eggs of the mackerel Scomber scombrus. *Mar Bio*l, 63(1): p. 101-106.

7 - Coombs, S.H., et al., 2004. Buoyancy measurements and vertical distribution of eggs of sardine (Sardina pilchardus) and anchovy *(Engraulis encrasicolus). Mar Biol*, 145(5): p. 959-970.

8 - Lett, C., et al., 2008. A Lagrangian tool for modelling ichthyoplankton dynamics. Environ Model Soft.

9 - Regner, S., 1996. Effects of environmental changes on early stages and reproduction of anchovy in the Adriatic Sea. *Sci Mar*, 60: p. 167-177.

SPHAEROMA WALKERI STEBBING,1905 (CRUSTACEA, ISOPODA, SPHAEROMATIDAE) INTRODUCED AND ESTABLISHED IN TUNISIA WATERS

Khadija Ounifi Ben Amor [1], Mohamed Ben Salem [1] and Jamila Ben Souissi [2]*

[1] Faculté des Sciences de Tunis, Unité de recherche zoologie et écologie des milieux aquatiques, Campu

[2] Institut National Agronomique de Tunisie, 43 Avenue Charles Nicolle, cité Mahrajène 1082, Tunis Tunisie. - bensouissi.jamila@inat.agrinet.tn

Abstract

During the last decades, 4 alien isopods have been reported from harbours and nearby lagoons in Tunisia. The intensification of shipping activities and the significant increase in the average water temperature has been enhanced the introduction and the establishment of non indigenous species. Since its occurrence *Sphaeroma walkeri* was studied. A brief description and some ecological main features are given and discussed.

Keywords: Infralittoral, Lagoons

Surveys conducted among benthic communities in Tunis Southern lagoon and nearby ports during last decades allowed us to observe 4 alien isopods, *Paracerceis sculpta* [1], *Paradella dianae* [2], *Sphaeroma walkeri* [3] and *Sphaeroma venustissimum* [4]. Among this invasive fauna, *Sphaeroma walkeri* is the most acclimated isopod with *Paracerceis sculpta* in the Tunisian brackish waters. According to Zibrowius [5] it is one of the most widely ship-transported alien species in the world, and was first recorded in the Mediterranean during the earlier part of the last century. *Sphaeroma walkeri* is a thermophilic isopod native of the Indian Ocean. It is commonly found in intertidal fouling communities and has been widely reported from ports in warm and warm-temperate waters worldwide [6]. *Sphaeroma walkeri* was regularly sampled from 2003 until 2009 in the Tunis Southern lagoon and the specimens have been identified following the description and illustrations given by Jacobs [7]. *Sphaeroma walkeri* is an isopod that grows up to 10mm in length (Figure 1). Adult females are smaller than adult males. Maximum length observed in our samples is 16mm.The surface of pereionites is smooth but pereonites 3 & 4 each bear 2 irregular rows of low tubercles. Pereonites 5 &6 and the pleon each bear one row of prominent round tubercles, with the posterior edge of the pleon having a second row of small round tubercles. The pleotelson is long and tapers to a rounded point that is slightly upturned with 4 rows of 3-6 tubercles running lengthways on the surface. The uropods are flattened and attached on the side of the pleotelson towards the front. The endopod is rigidly fused while the exopod is movable and greater than or equal to the length of endopod. *S. Walkeri* was permanently collected in Tunis Southern Lagoon, a euryhalin ecosystem, among sponges and ascidians in very shallow waters less than 3 metres depth. This isopod was the most abundant alien species found in Tunis Southern lagoon during hot season from April to August. Salinity, temperature and suspended solids were observed to influence the occurrence of this species. This specie is commonly associated with one or both of the isopods *Dynamenella dianae* and *Paracerceis sculpta*. The evolution of densities of *Sphaeroma walkeri* according seasons is summarized in table1. This isopod is found in high densities. The average value observed was 15 specimens /m^2. The highest values have been observed during the hottest season. Among fouling communities, *S. Walkeri* prefers sponges than ascidians. The specie reproduces in sponges. All stages, adult from the two sexes, ovigerous and non-ovigerous females and sub-adult males, are observed in sponges.

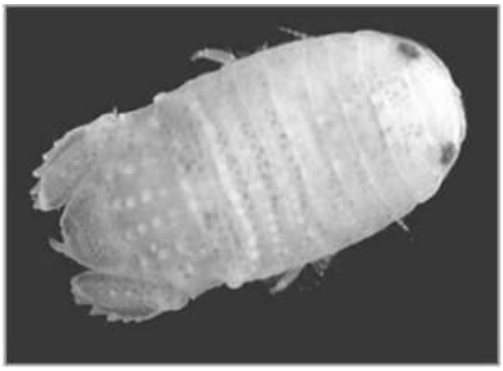


Fig. 1. Male of Sphaeroma walkeri Stebbing, 1905 collected from the Tunis Southern lagoon

Tab. 1. Seasonal evolution of densities of S. walkeri in Tunis Southern Lagoon

Seasons	Autumn	winter	spring	summer
Densities of *S. Walkeri* associated to sponges	12 ind/m^2	7 ind/m^2	18 ind/m^2	23 ind/m^2
Densities of *S. Walkeri* associated to ascidians	3 ind/m^2	2 ind/m^2	7 ind/m^2	9 ind/m^2

S. walkeri is one of the most abundant alien isopods observed in Tunisian shallow waters. According its establishment and acclimatisation in lagoons near ports, this thermophilic non indigenous species was probably introduced by vessels traffic.

References

1 - Rezig M., 1978. Sur la présence de *Paracerceis sculpta* (Crustacé, Isopode, Flabellifère) dans le lac de Tunis. *Bull. Off. Natn. Pêch. Tunisie*, 2 (1-2): 175-191.

2 - Bey A., Rezig M., Ben Souissi J. and Dridi M.S., 2001. Première mention de *Paradella dianae* (Menzies, 1962) (Crustacé, Isopode) dans le lac sud de Tunis, Etude morphologique et écologique de l'espèce. *Bull. Soc. Zool. Fr.* 126 (1-2): 220-223.

3 - Ben Souissi J, Zaouali J., Rezig M, Bardai MN, Quignard J.P. and Rudman B., 2004. Contribution à l'étude de quelques récentes migrations d'espèces exotiques dans les eaux tunisiennes. Rapports et procès-Verbaux des réunions, Commission Internationale pour l'Exploration Scientifique de la mer Méditerranée 37 : 302.

4 - Ben Souissi J, Trigui El Menif N., Mahjoub M.S., Méjri H., Quignard J.P., Capapé C. and Zaouali J., 2005. On the recent occurrence of marine exotic species in Tunisian waters. *Proceedings of the Seventh International Conference on the Mediterranean Coastal Environment, MEDCOAST 05, E. Özhan(Editor)*, 25-29 October 2005, Kusadasi, Turkey: 529-540.

5 - Zibrowius H., 1992. Ongoing modification of the Mediterranean fauna and flora by the establishment of exotic species. *Mésogée* 51: 83-107.

6 - Gallil B., 2008. *Sphaeroma walkeri* Stebbing., 1905. (Crustacea: Isopoda: Sphaeromatidae) established on the Mediterranean coast of Israel. *Aquatic Invasions*. 3, (4): 443-444.

7 - Jacobs B.J.M., 1987. A taxonomic revision of the European Mediterranean and NWS African species generally placed in *Sphaeroma* Bosc, 1802 (Isopoda: Flabellifera: Sphaeromatidae). *Zoologische Verhandelingen* .238: 1-71.

THE BIOMASS AND SOME BIOLOGICAL ASPECTS OF THE MEDITERRANEAN SLIMEHEAD *HOPLOSTETHUS M. MEDITERRANEUS*, FROM SAROS BAY (NE AEGEAN SEA, TURKEY)

Melike idil Öz [1]* and Ali Ismen [1]
[1] Çanakkale Onsekiz Mart University, Faculty of Fisheries - idiloz@gmail.com

Abstract
The CPUE, biomass indices and some aspects of the biology of *Hoplostethus mediterraneus mediterraneus* from Saros Bay (NE Aegean Sea) are determined. Specimens were caught by commercial trawl from the depth interval 200-500 m, in the period of January 2005-September 2008. Lenght-weight relationship is found $W=0{,}0101*L^{3{,}1041}$ for both sexes. Total lenght and total weight ranged from 4,0 to 24,6 cm and from 0,83 to 209,7 g respectively.
Keywords: Biomass, Aegean Sea, Trawl Surveys

With the arisen awareness of the 'ecosystem-based fisheries management', discarded species are no longer considered as less important constituents of the integrated ecosystem. However information is still scarce regarding many non-commercial species' distribution, population status and biology. The Mediterranean slimehead is a good example for this situation. *Hoplostethus mediterraneus mediterraneus* Cuvier, 1829 (Beryciformes: Trachichthyidae), having no commercial value in the Mediterranean Sea fisheries, is a cosmopolitan, benthopelagic, marine species living at a depth range of 100 - 1175 m [1]. This species has received relatively little scientific attention and many basic aspects of its biology are as yet unknown. [2].

Methods
Samples were collected by a commercial bottom trawl net with a cod end stretched mesh size of 22 mm, at monthly sampling intervals from January 2005 to September 2008. *H. mediterraneus mediterraneus* specimens were caught from the depth range of 200-500 m, tow duration was restricted to 30 min and the vessel speed was kept constant at 2,7 knots during hauling. CPUE was calculated for 1 hour, biomass was estimated using the swept area method. Total length, weight and if possible sex and maturation stage were recorded for each specimen, also some of the gonads, stomachs and otoliths were dissected and sampled in order to evaluate for further studies. Length-weight relationship were calculated and expressed $W=aL^b$.

Results and Discussion
The CPUE and biomass indices show that *H. mediterraneus mediterraneus* is widely distributed in Saros Bay.

Tab. 1. CPUE (kg/h) and biomass (kg/km^2) indices of *H. mediterraneus mediterraneus* in Saros Bay. *)Month represented by only one specimen, **) Month represented by juveniles only

	2005		2006		2007		2008		MEAN	
	CPUE	BI	CPUE	BI	CPUE	BI	CPUE	BI	CPUE	BI
Jan.	0	0	0,62	10,09	12,40	203,28	*0,08	*1,34	**3,27**	**53,68**
Feb.	0	0	0,11	1,85	0	0	4,20	68,85	**1,08**	**17,68**
Mar.	0,47	7,69	**0,10	**1,67	0	0	0,72	11,80	**0,32**	**5,29**
Apr.	4,56	74,82	1,59	25,99	*0,01	*0,13	No sampling		**2,05**	**33,64**
May	0	0	0,39	6,47	1,76	28,80	0	0	**0,54**	**8,82**
June	101,73	1667,76	0	0	0	0	0	0	**25,43**	**416,94**
July	0	0	2,40	39,29	0	0	**0,26	**4,22	**0,66**	**10,88**
Aug.	0	0	*0,02	*0,30	0	0	0	0	**0**	**0,07**
Sep.	0	0	0	0	0	0	0	0	**0**	**0**
Oct.	0	0	1,80	29,51	64,15	1051,57	No sampling		**21,98**	**360,36**
Nov.	91,30	1496,78	*0,01	*0,13	15,71	257,47	No sampling		**35,67**	**584,80**
Dec.	0	0	0	0	0	0	No sampling		**0**	**0**
MEAN	**16,51**	**270,59**	**0,59**	**9,61**	**7,84**	**128,44**	**0,66**	**10,78**		

According to Table 1, especially in October and November the values are much higher than the other months of the years. On the contrary, June'05 is an exception, but the other summer months and May values are low and September values are zero for all the four years. For these 5 months we may assert that fish inhabit deeper levels that our gear was unable to reach. This behavior can be estimated as the effects of changes in the water temperature or as a spawning behavior. Yet the spawning period is given in [3] as May-September which reflects the absence of *H. mediterraneus mediterraneus* in our study.

Overall, 305 sexed individuals, 171 were female (56%), 73 were male (24%) and 61 were juveniles (20%). Juveniles were mostly captured at depths between 300-440 m, in May'06, July'06 and '08. The most frequent size class for both sexes is 15 cm, for females 17 cm and for males 15 cm.

The parameters of the length-weight relationship of our study and previous studies on the same species from different localities are given in Table 2.

Tab. 2. Sample size (n), min. and max. length and weight, parameters of length-weight relationships (*a* and *b*) and the coefficient of determination (r^2) from various studies and the present study (*)

Ref.	Locality	Country	L_{min}	L_{max}	W_{min}	W_{max}	n	*a*	*b*	r^2
4	Balearic Islands	Spain	4,3	21,1			101	0,0083	3,150	0,998
5	Algarve	Portugal	6,3	17,0	1,1	75,6	59	0,0179	2,865	0,920
2	Algarve	Portugal								
	Combined		4,0	21,0			429	0,0075	3,214	0,968
	Female		7,0	21,0			35	0,0085	3,159	
	Male		7,0	17,0			37	0,0028	3,581	
6	N Aegean Sea	Turkey	8,0	18,0	7,23	81,64	137	0,0149	2,950	0,980
*	Saros Bay	Turkey								
	Combined		4,0	24,6	0,83	209,7	1562	0,0101	3,104	0,991
	Female		8,2	22,4	6,76	168,56	171	0,0097	3,130	0,977
	Male		11,0	19,5	17,80	111,00	73	0,0107	3,096	0,967

References
1 - Froese, R. and Pauly, D. Editors., 2009. FishBase. World Wide Web electronic publication. www.fishbase.org, version (09/2009).
2 - Pais C., 2001. Aspects of the biology of *Hoplostethus mediterraneus* from the south coast of Portugal. *J. Mar. Biol.* Ass. U.K. 81: 711-712.
3 - D'Onghia G., Tursi A., Marano C.A. and Basanisi M.,1998. Life history traits of *Hoplostethus mediterraneus* (Pisces: Beryciformes) from the North-Western Ionian Sea (Mediterranean Sea). *J. Mar. Biol.* Assoc. U.K. 78:321-339.
4 - Merella P., Quetglas A., Alemany F. and Carbonell A., 1997. Length-weight relationship of fishes and cephalopods from the Balearic Islands (western Mediterranean). Naga ICLARM Q. 20(3/4):66-68.
5 - Borges T.C., Olim S. and Erzini K.,2003. Weight-length relationship for fish species discarded in commercial fisheries of the Algarve (southern Portugal). *J. Appl. Ichthyol*. 19(6):394-396.
6 - Filiz H. and Bilge G.,2004. Length-weight relationships of 24 fish species from the North Aegean Sea, Turkey. *J. Appl. Ichthyol*. 20:431-432.

THE STATUS OF THE EXOTIC FISH SPECIES IN THE GULF OF ANTALYA, TURKEY (LEVANTINE SEA)

E. Özgür Özbek [1]*, T. Kebapçioglu [1], M. Çardak [2], M. Gökoglu [1] and C. R. Begburs [1]
[1] Akdeniz University, Faculty of Fisheries - eozgur@akdeniz.edu.tr
[2] Istanbul University, Faculty of Fisheries

Abstract
This paper presents the abundance and biomass of the 18 exotic fish species caught during the bottom trawl survey carried out in the Gulf of Antalya in the summer period of 2009. Among 76 teleost species identified, exotics constituted 9.74% of the average abundance and 7.93% of the average biomass of the teleosteans.
Keywords: Trawl Surveys, Demersal, Teleostei, Biomass, Levantine Basin

Introduction
The Gulf of Antalya locates in the Norteastern Levantine Basin and is highly susceptible to invasions by aliens due to the proximity to the Suez Canal. 120 established and casual alien fish were reported from the Mediterranean Sea [1] and 50 of them were recorded from the Levantine coast of Turkey [1,2]. Except for the species records, the studies concerning the biomass and abundance of the exotic fish community in the Northeastern Levant Sea are limited to [3,4]. This paper presents the first detailed information on the exotic fish community of the Gulf of Antalya.

Material and Methods
This research was carried out in August 2009, in the Gulf of Antalya, between the depths of 25-200 m, using a commercial bottom trawler. The cod-end mesh size 22 mm (knot to knot). The samples were collected day time with 2.5 n.m./h average trawling speed. The geographical coordinates of 30 trawling stations vary between N36° 52' 48.5 - 36° 23' 00.0'' - E31° 32 32.2' - E30° 31' 11.3''. The total catch from each haul was identified to species, counted, weighed and standardized to unit trawling hour. The stock amount is calculated according to the swept area method [5].

Results
A total of 30 hauls were carried out at the depths of 25, 50, 75, 100, 150, 200 m. The overall average abundance of the 18 exotic species was 4942±1371 ind./nm^2 (±se) and average biomass was 229,67±49,58 kg/nm^2 (±se) (Tab.1).

Tab. 1. The number of hauls, average biomass (kg/nm^2 ±se), abundance (ind./nm^2 ±se) and number of exotic species and percentages of exotics in among teleosteans at six depth levels in the Gulf of Antalya.

Depth (m)	Number of hauls	Average Biomass kg/nm^2±se (%)	Average Abundance ind./nm^2±se (%)	Number of Species (%)
25	6	348.30 ±151.88 **(14.47)**	15342 ±4560 **(17.42)**	15 **(29.41)**
50	6	409.11 ±112.36 **(17.81)**	5291 ±1546 **(9.81)**	12 **(22.22)**
75	6	156.06 ±71.61 **(6.99)**	1683 ±608 **(3.13)**	10 **(20.83)**
100	6	170.3 ±112.19 **(6.21)**	1691 ±1122 **(2.81)**	3 **(9.38)**
150	4	96.51 ±49.52 **(3.52)**	1036 ±665 **(1.49)**	7 **(19.44)**
200	2	0.69 ±0.69 **(0.08)**	40 ±40 **(0.14)**	1 **(4.76)**
Total	30	229.67 ±49.58 **(9.74)**	4942 ±1371 **(7.93)**	18 **(23.68)**

The highest biomass of the exotic species was recorded at the depth of 50 m and the abundance decreased with depth. The most frequent species was *Saurida undosquamis* (Linnaeus, 1758) (83,3%), *Upeneus moluccensis* (Bleeker, 1855) (83,3%), *Lagocephalus suezensis* Clark & Gohar, 1953 (36,7%), *Lagocephalus sceleratus* (Gmelin, 1789) (36,7%), and *Equulites klunzingeri* (Steindachner, 1898) (30%). In the total average of 30 hauls, *S. undosquamis* (Linnaeus, 1758), *L. suezensis* Clark & Gohar, 1953, *U. moluccensis* (Bleeker, 1855), *L. sceleratus* (Gmelin, 1789), and *E. klunzingeri* (Steindachner, 1898) are the species that have the highest biomass. *E. klunzingeri* (Steindachner, 1898), *U. moluccensis* (Bleeker, 1855), *S. undosquamis* (Linnaeus, 1758), *L. suezensis* Clark & Gohar, 1953, and *Upeneus pori* Ben-Tuvia & Golani, 1989have the highest abundance, respectively. The average biomass (kg/nm^2 (±se)), and abundance (ind./nm^2 (±se)) of 18 exotic species at six depth levels are given in Table 2.

Tab. 2. The average biomass (kg/nm^2 (±se)), and abundance (ind./nm^2 (±se)) of 18 exotic species caught by trawl, at six depth levels in the Gulf of Antalya.

Species / Depth	25M	50M	75M	100M	150M	200M
Average Biomass (kg/nm^2±se)						
Callionymus filamentosus	4.4±4.1	0.5±0.4	0.1±0.1	-	-	-
Dussumieria elopsoides	-	0.4±0.4	-	-	-	-
Equulites klunzingeri	37.3±24.7	12.9±9.0	1.5±1.4	-	-	-
Etrumeus teres	-	-	-	-	0.9±0.9	-
Fistularia commersonii	0.2±0.2	-	-	-	-	-
Lagocephalus sceleratus	15.4±15.1	35.0±20.4	4.4±4.4	20.2±13.0	21.1±18.0	-
Lagocephalus spadiceus	5.0±3.2	0.1±0.1	1.6±1.6	-	14.3±10.1	-
Lagocephalus suezensis	135.2±89.3	18.1±10.1	3.2±3.2	-	3.2±3.2	-
Nemipterus randalli	1.7±1.7	0.8±0.7	-	-	-	-
Oxyurichthys papuensis	0.5±0.3	0.3±0.2	0.3±0.2	-	0.5±0.5	-
Saurida undosquamis	111.7±59.1	293.9±100.1	102.1±72.1	38.5±17.1	25.3±10.4	-
Sigamus rivulatus	-	-	1.8±1.8	-	-	-
Sillago sihama	1.4±1.4	0.2±0.2	-	-	-	-
Sphoeroides pachygaster	0.2±0.2	-	-	-	-	-
Sphyraena chrysotaenia	0.6±0.6	-	1.4±1.4	-	-	-
Stephanolepis diaspros	0.9±0.9	-	-	-	-	-
Upeneus moluccensis	23.6±8.4	42.7±14.9	39.7±20.3	111.6±87.2	31.2±20.6	0.7±0.7
Upeneus pori	10.1±4.4	4.3±4.0	-	-	-	-
Average Abundance (ind./nm^2±se)						
Callionymus filamentosus	474±430	38±29	9±9	-	-	-
Dussumieria elopsoides	-	30±30	-	-	-	-
Equulites klunzingeri	9558±4739	1369±901	327±209	-	-	-
Etrumeus teres	-	-	-	-	14±14	-
Fistularia commersonii	83±53	-	-	-	-	-
Lagocephalus sceleratus	84±53	94±47	18±18	113±74	55±41	-
Lagocephalus spadiceus	160±141	6±6	28±28	-	25±15	-
Lagocephalus suezensis	2863±1767	646±364	64±64	-	72±72	-
Nemipterus randalli	38±38	19±12	-	-	-	-
Oxyurichthys papuensis	24±17	20±13	19±12	-	29±29	-
Saurida undosquamis	837±411	1881±764	532±312	266±103	172±77	-
Sigamus rivulatus	-	-	35±35	-	-	-
Sillago sihama	41±41	6±6	-	-	-	-
Sphoeroides pachygaster	7±7	-	-	-	-	-
Sphyraena chrysotaenia	7±7	-	10±10	-	-	-
Stephanolepis diaspros	29±22	-	-	-	-	-
Upeneus moluccensis	555±150	1017±416	641±277	1313±988	669±437	40±40
Upeneus pori	582±283	166±150	-	-	-	-

Discussion This paper presents the first detailed information on the exotic fish community of the Gulf of Antalya. This research was conducted in the "pre-fishing" season both in the fishing-prohibited and open areas. For the "pre-fishing" season, [3] reported that the Red Sea teleosteans constituted 51.91% of the average percentage of the teleosteans and decreased to 34.85% in the post fishing season in Gulfs of Iskenderun and Mersin. The keystone species responsible for this fluctuation was shown as *E. klunzingeri* (Steindachner, 1898) which was also found as the most abundant species in this study. Invading species have been found to comprise 62% of the demersal fish biomass in the Gulf of Iskenderun and 34% in Mersin Bay, Turkey [4]. Notwithstanding, definite changes in fish communities in the Levantine ecosystem have been attributed to Lessepsian migrants. Thus long-term approaches are required to monitor of the exotics in proportion to local species; determine the seasonal and spatial distribution and status of the populations of alien species. **Acknowledgements** The authors greatly indepted to Prof.Dr.Erhan MUTLU, Prof.Dr.Gülsen ALTUG, Assoc.Prof.Dr.Saadet F. KARAKULAK and Assoc.Prof.Dr.Murat BILECENOGLU for their valuable comments and support and Captain Akin AKYAR for his help on the field works.

References
1 - Zenetos A., Meriç E., Verlaque M., Galli P., Boudouresque C.F., Giangrande A., Çinar M. E. and Bilecenoglu M., 2008. Additions to the annotated list of marine alien biota in the Mediterranean with special emphasis on Foraminifera and Parasites. *Medit. Mar. Sci.*, 9/1: 119-65.
2 - Çinar M.E., Bilecenoglu M., Öztürk B., Katagan T. and Aysel V., 2005. Alien species on the coasts of Turkey. *Medit. Mar. Sci.*, 6/2: 119-46.
3 - Gücü A.C., Bingel F., Avsar D. and Uysal N., 1993. Distribution and occurrence of Red Sea fish at the Turkish Mediterranean coast - northern Cilician Basin. *Acta Adriat.*, 34: 103-113.
4 - Gücü A.C. and Bingel F., 1994. Trawlable species assemblages on the continental shelf on the North Eastern Levant Seas (Mediterranean) with an emphasis on Lessepsian migration. *Acta Adriat.*, 35: 83-100.
5 - Spare P. and Veneme S.C. 1992. Introduction to Tropical Fish Stock Assesment (Part 1). *FAO Fish. Tech. Pap.*, Rome.

COMPARISON OF FATTY ACID, TRACE ELEMENT AND PROXIMATE COMPOSITIONS OF MALE AND FEMALE OF BLUE CRABS AND SWIM CRABS FROM MERSIN BAY, TURKEY

Y. Ozogul [1], D. Ayas [2]*, F. Ozogul [1], G. Ozyurt [1], E. B. Kuley [1] and H. Yazgan [1]
[1] Cukurova University, Faculty of Fisheries, Seafood Proccessing Technology
[2] Mersin University, Faculty of Fisheries, Seafood Processing Technology - ayasdeniz@mersin.edu.tr

Abstract
Fatty acid, trace element and proximate compositions of male and female of blue crabs and swim crabs caught in Mersin Bay were investigated. The results of proximate analysis showed that there were variations in protein and moisture content of both female crabs and male crabs' meat of these two crab species ($p<0.05$). Saturated fatty acid (SFA) content was detected as 23.3%-24.8% in blue crabs whereas it was 24.7%-24.9% in swim crabs. Monounsaturated fatty acid (MUFA) content in the body of blue crabs (26.6%-29.6%) was higher than swim crabs (24.1%-25.9%). Besides, polyunsaturated fatty acid (PUFA) content of swim crabs (43.8%-45.3%) was higher than blue crabs (39.2%-42.8%) ($p<0.05$). It was also found that crab meat was rich in terms of trace element content, especially Cu, Zn, and Fe.
Keywords: Decapoda, Metals, Nutrients

Introduction
Poturnid crabs, *Callinectes sapidus* and *Portunus pelagicus*, are the most important members of the estuarine food chain as while they feed on fish, aquatic vegetation, molluscs, crustaceans and annelids, they serve as preys to mammals, birds and fishes [1]. Seafood lipids are rich in n-3 PUFAs such as EPA and DHA. These fatty acids have a variety of health benefits, including prevention of sudden cardiac death [2] and chemopreventive effects of cancer [3]. The fat and fatty acid compositions of fish can vary depending on fish species, diet, gender, location and season of capture [4,5]. The objective of this study was to determine and compare trace element, fatty acid and proximate compositions of male and female blue crabs and swim crabs in Mersin Bay.

Materials and Methods
Poturnid crabs, *C. sapidus* and *P. pelagicus*, were caught by dip net from Mersin Bay, the coast of Northeastern Mediterranean, in March, 2008. In the fishing procedure, dip net which had mesh size of 32 mm was used. The morphometric measurements [carapace length (CL), carapace width (CW) and weight] of all samples were carried out. The morphometric measurements of crab carapace were done using a caliper. The mean CW and CL were 183.4-214.0 mm and 79.0-95.6 mm for blue crabs and 172.8-183.0 mm and 90.3-111.0 mm for swim crabs, respectively. The mean weights of blue crabs and swim crabs were between 180.8-238.6 g and 174.3-177.8 g, respectively. Crab samples were analysed in triplicate for proximate composition. Lipid content by the Bligh and Dyer [6] method, moisture content by AOAC [7] method, total crude protein by the Kjeldahl method [8] and ash content by the AOAC [7] method. Fatty acid profiles of fat extracted from the blue crab samples were determined by gas chromatography (GC) of methyl esters. Methyl esters were prepared by transmethylation using 2 M KOH in methanol and n-heptane according to the method decribed by Ichibara et al. [9] with minor modification. All samples were analysed three times for each metals with ICP-AES (Inductively Coupled Plasma Atomic Emission Spectrometry, Varian® model- Liberty Series II). The standard addition method was used to correct for matrix effects. The metal concentration (Cd, Cr, Pb, Cu, Fe and Zn) in tissue was recorded as µg metal/g dry weight [10]. Statistical analysis of data was carried out with the SPSS statistical program. ANOVA (Analysis of Variance) was used to evaluate the effect of gender on the fatty acid and proximate composition and trace element levels.

Results and Discussion
The results showed that the protein, lipid, moisture, and ash contents of female blue crabs and female swim crabs were not significantly ($P>0.05$) different. Protein contents of female blue crabs and female swim crabs were significantly higher ($P<0.05$) than those found in male blue crabs and male swim crabs. Moisture contents of male blue crabs and male swim crabs were significantly higher ($P<0.05$) than those found in female blue crabs and female swim crabs. This study shows that crabs caught from the Gulf of Mersin have high protein (21.4-22.5% for *C. sapidus* and 20.9–23.2% for *P.pelagicus*) and low fat contents (1.0–1.1% for *C. sapidus* and 1.2–1.3% for *P. pelagicus*). In this study, lipid values were higher than those reported by Gökoglu et al. [11] for the both crab species. *Fatty acids composition;* SFAs, MUFAs, PUFAs, PUFA/SFA, n-3 acids, n-6 acids and the n6/n3 ratio of male and female swim crabs and blue crabs' meat are presented in Table 1. The dominant SFAs were palmitic acid (12.8%-14.2%), and stearic acid (6.4%-9.0%) for both of the crab species. Oleic acid (13.3%-14.8%) was the major MUFA in all crab meats, followed by palmitoleic acid (5.0%-8.7%) and octadecenoic acid (4.0-4.7%). The total PUFA value was the highest in meat of female swim crabs (43.75%), the lowest amounts (39.15%) were in meat of female blue crabs. EPA (20:5) and DHA (22:6) were PUFAs having maximal values. Statistically, there were no significant differences in Eicosapentaenoic acid (EPA) concentrations in body meat of male and female blue crabs ($P>0.05$). Besides, EPA concentrations in meat of female swim crabs were higher than those of the males ($p<0.05$). *Trace element contents;* the trace element contents of female and male of blue crab and swim crab are listed in Table 2. Cu, Zn, Fe contents of female blue crabs were significantly higher ($P<0.05$) than those found in male blue crabs. Cd, Pb, Zn contents of female swim crabs were significantly higher ($P<0.05$) than those found in male swim crabs. The concentrations of metals for muscle of crab are below those likely to cause a public health problem: 4 µg Cd/g (wet weight), 1.7 µg Pb/g according to the U.S. Food and Drug Administration [12] and 20 µg Cu/g and 50 µg Zn/g according to the Turkish Food Codex [13]. High Cu level doesn't directly affect human health. But the excess copper ve zinc is carried via the food chain to the upper trophic levels and creates important ecological problems.

References
1 - Hall D., Lee S.Y. and Meziane T. 2006. Fatty acids as trophic tracer in an experimental estuarine food chain: Tracer transfer. *Journal of Experimental Marine Biology and Ecology*, 336: 42-53.
2 - Leaf A., Xiao Y.F., Kang J.X. and Billman G.E. 2003. Prevention of sudden cardiac death by *n*-3 polyunsaturated fatty acids. *Pharmacology and Therapeutics*, 98: 355-377.
3 - Akihisa T., Tokuda H., Ogata M., Ukiya M., Lizuka M., Suzuki T., Metori K. Shimizu N. and Nishino H. 2004. Cancer chemopreventive effects of polyunsaturated fatty acids. *Cancer Letters*, 205: 9-13.
4 - Ayas D., Ekingen G. and Çelik M. 2005. Seyhan Baraj Gölü pullu sazanlarinin (*Cyprinus carpio* L. 1758) mevsimsel besin kompozisyonu ile sicak tütsüleme sonrasi kimyasal ve duyusal degisimleri. *Süleyman Demirel Üniversitesi Egirdir Su Ürünleri Fakültesi Dergisi*, 1(1): 12-20.
5 - Özogul Y., Özogul F. and Alagöz S. 2007. Fatty acid profiles and fat contents of commercially important seawater and freshwater fish species of Turkey: A comparative study. *Food Chemistry*, 103: 217-223.
6 - Bligh EC, Dyer WJ. 1959. A rapid method of total lipid extraction and purification. *Canadian Journal Biochemical Physiology*, 37: 913-917.
7 - AOAC. 1998. Official method 955.04. Nitrogen (total) in seafood. Fish and other marine products. In: Hungerford JM, chapter editor; Cunniff P, editor. Official methods of analysis of AOAC International.chapter 35, p. 6. Arlington, WA.
8 - AOAC. 1998. Official method 955.04. Nitrogen (total) in seafood. Fish and other marine products. In: Hungerford JM, chapter editor; Cunniff P, editor. Official methods of analysis of AOAC International.chapter 35, p. 6. Arlington, WA.
9 - Ichibara K., Shibahara A., Yamamoto K. ve Nakayama T. 1996. An improved method for rapid analysis of the fatty acids of glycerolipids. *Lipids*, 31: 535-539.
10 - Kalay M., Sangün M.K., Ayas D. and Göçer M. 2008. Chemical composition and some trace element levels of thinlip mullet, *Liza ramada* caught from Mersin Gulf. *Ekoloji*, 17 (68):11-16.

THE EFFECTS OF SEASON AND SEX IN THE FATTY ACIDS AND PROXIMATE COMPOSITIONS OF COMMON CUTTLEFISH (*SEPIA OFFICINALIS*)

Yesim Ozogul [1], Deniz Ayas [2]* and Mustafa Kalay [2]
[1] Cukurova University, Faculty of Fisheries, Seafood Proccessing Technology
[2] Mersin University - ayasdeniz@mersin.edu.tr

Abstract

The effects of season and sex on the fatty acids and proximate compositions of the mantle of the cuttlefish *S. officinalis* were evaluated. The results of the proximate composition showed that the level of protein contents of female of *S. officinalis* were significantly higher than those of male (P<0.05) for all seasons. In addition, lipid and moisture contents of female of cuttlefish were generally low compared to those of male cuttlefish. The fatty acid compositions of each sex and all seasons ranged from 29.38% to 32.51% saturated (SFA), 8.70-11.11% monounsaturated (MUFAs) and 48.23-54.57% polyunsaturated acids (PUFAs). The proportions of *n*-3 PUFAs (44.00-50.63%) were higher than *n*-6 PUFAs (3.38-4.25%) regardless of sex and seasons.

Keywords: Cephalopods, Nutrients

Introduction Cephalopoda, one of the most important groups of marine invertebrates, are consumed throughout the world. Annual catch of cuttlefish ranged from 11,000 to 15,000 tons throughout the world and they occupies an important place among cephalopoda [1]. Bochemical contents of marine organisms have been reported to change due to seasonal changes [2,3,4]. Studies have been conducted on the nutrient value and fatty acid composition of cuttlefish [5,6,7]. In this study, the effects of season and sex in the fatty acids and proximate compositions of the mantle tissue of the common cuttlefish (*Sepia officinalis*) were investigated.

Materials and Methods

The common cuttlefish is generally caught in the Mediterranean and Eagen sea shore in Turkey. This species was caught in Mersin Bay with net in all seasons (except summer). Mantle which is the main edible portion of cuttlefish was homogenized and chemical analyses were done on this part of fresh samples. The analyses were performed at least in triplicate. Lipid content by the Bligh and Dyer [8] method, moisture content by AOAC [9] method, total crude protein by the Kjeldahl method [10] and ash content by the AOAC [9] method. Fatty acid profiles of fat extracted from samples were determined by gas chromatography (GC) of methyl esters. Methyl esters were prepared by transmethylation using 2 M KOH in methanol and n-heptane according to the method decribed by Ichibara et al. [11] with minor modification. Statistical analysis of data was carried out with the SPSS statistical program. ANOVA (Analysis of Variance) was used to evaluate the effect of gender on the fatty acid and proximate composition and trace element levels.

Results and Discussion

Tab. 1. Seasonal changes in fatty acid composition of *S.officinalis*

Food Category (% by weight)	Identified prey items	Food Category (% by weight)	Identified prey items
Teleostei (58.67%)	*Argentina sphyraena*	Crustacea (19.25%)	*Alpheus glaber*
	Echelus myrus		Amphipoda
	Gnathophis mystax		*Atelecyclus rotundatus*
	Macroramphosus scolopax		*Chlorotocus crassicornis*
	Trachurus trachurus		Crangonidae
	Zeus faber		*Goneplax rhomboides*
Cephalopoda (16.36%)	*Eledone* sp.		*Munida* sp.
	Octopus defilippi		*Nephrops norvegicus*
	Sepiolidae		*Pagurus* sp.
Polychaeta (3.89%)	Aphroditidae		*Parapenaeus longirostris*
Plantae (0.06%)	*Posidonia oceanica*		Pasiphaeidae
			Platysquilloides lilljae
Cannibalism (1%)	*Scyliorhinus canicula*		*Sergestes* sp.
			Squillidae

Fatty acid analyses; Table 1 shows the seasonal changes in fatty acid composition of male and female cuttlefish. The fatty acid compositions of each sex and all seasons ranged from 29.38% to 32.51% saturated (SFA), 8.70-11.11% monounsaturated (MUFAs) and 48.23-54.57% polyunsaturated acids (PUFAs). The major fatty acids found in cuttlefish were myristic acid (C14:0, 1.56-2.43%), palmitic acid (C:16, 16.38-19.24%), heptadecanoic acid (C17:0, 1.41-1.63%), stearic acid (C:18, 7.45-9.27%), oleic acid (18:1 *n*-9, 3.31-5.15%), linoleic acid (C18:2 *n*-6, 0.49-0.77), arachidonic acid (C20:4 *n*-6, 2.78-3.38%), *cis*-11-eicosapentaenoic acid (EPA, C20:5 *n*-3, 15.73-17.75%) and *cis*-4,7,10,13,16,19-docosahexaenoic acid (DHA, C22:6 *n*-3, 27.46-33.02%). These results were in agreement with those reported by Ozyurt et al. [7],Reale et al. [12],and Ozogul et al. [13]. The proportions of *n*-3 PUFAs (44.00-50.63%) were higher than *n*-6 PUFAs (3.38-4.25%) regardless of sex and seasons. This high PUFA level is similar to those reported [2,5,7,12,13]. The major polyunsaturated fatty acids of cephalopoda observed were EPA and DHA. In this study, the levels of DHA, which was recorded in autumn, spring and winter, were 31.54%, 27.46%, and 28.70% for female cuttlefish, respectively, whereas its level were observed to be 33.02%, 29.23% and 28.70% for male cuttlefish. The EPA levels in female of cuttlefish mantle were found to be 17.75%, 16.26%, 15.73% and 13.9% while its level in male of cuttlefish were 15.85%, 17.22% and 16.80% in autumn, spring and winter, respectively. It is well known that the fatty acid profile of fish muscle reflects the content of the dietary lipid sources. Nutrient levels vary between species and even within species. Diet, size, age, reproductive status of fish, environmental conditions, and especially water temperature, influence lipid content and fatty acid composition of seafood.

Proximate analyses; Table 2 shows seasonal changes in proximate composition of male and female of cuttlefish. The results of the proximate composition showed that the lowest lipid content was obtanied from female in winter (0.74%) whereas the highest level of lipid was found in males in Autumn (0.94%). The lowest total mineral substance (TMS) content was obtained in Autumn (1.07-1.08%), whereas the highest level of TMS was obtained in Spring (1.73-1.75%) in both female and male. The lowest protein content was also obtained in Autumn (16.96-17.33%). However, the protein contents did not change in both Spring (21.47-22.18%) and winter (21.64-22.01%) seasons. For all seasons, the level of protein contents of female of *S. officinalis* were significantly higher than those of male (P<0.05). In addition, lipid and moisture contents of female of cuttlefish were generally low compared to those of male cuttlefish.

Tab. 2. Seasonal changes in proximate composition of *S.officinalis*

Composite	Autumn		Spring		Winter	
	♀	♂	♀	♂	♀	♂
Protein	22.18±0.00^{b}	21.47±0.18^{a}	17.33±0.10^{a}	16.96±0.15^{a}	22.01±0.12^{b}	21.64±0.28^{a}
Lipid	0.89±0.04^{a}	0.91±0.02^{a}	0.84±0.06^{a}	0.94±0.02^{b}	0.74±0.00^{a}	0.82±0.00^{b}
Moisture	75.00±0.02^{a}	75.78±0.07^{b}	80.65±0.08^{a}	80.75±0.09^{a}	75.44±0.34^{a}	75.52±0.19^{a}
TMS	1.75±0.03^{b}	1.73±0.01^{c}	1.07±0.10^{a}	1.08±0.04^{a}	1.64±0.05^{b}	1.59±0.02^{c}

Different letters (a-b) in the same row are significantly different (P<0.05).

References

1 - FGIS, 2004 Fisheries Global Information System (FIGIS). (September, 2004). Available from http://www.fao.org/figis/servlet/FiRefServlet?ds=species and fid = 2711.

2 - Ackman, R.G., 1995. Composition and nutritive value of fish and shellfish lipids. In: A. Ruither, Editor, *Fish and fishery products*, CAB International, UK, pp. 117–156.

3 - Gamez-Meza N., Higuera-Ciapara L., Calderon A.M., Barca De La, Vazquez-Moreno L., Noriega-Rodriguez J. and Angulo-Guerrero O., 1999. Seasonal variation in the fatty acid composition and quality of sardine oil from *Sardinops sagax caeruleus* of the Gulf of California, *Lipids*, 34: 639–642.

4 - Orban E., Lena G.Di., Nevigato T., Casini I., Marzetti A. and Caproni R., 2002. Seasonal changes in meat content, condition index and chemical composition of mussels (*Mytilus galloprovincialis*) cultured in two different Italian sites, *Food Chemistry*, 77: 57–65.

5 - Shchenikova N.V., Pavlycheva E.V., Davydova S.A., Isa S.V. and Sokolova L.I., 1987. Fatty acid composition of the lipids of the mantle and liver of cephalopod mollusks, *Voprosy Pitaniia*, 6: 61–64.

6 - Sinanoglou V.J. and Miniadis-Meimaroglou S., 1998. Fatty acid of neutral and polar lipids of (edible) Mediterranean cephalopods. *Food Research International*, 31: 467–473.

A PRELIMINARY STUDY ON TWO SEAMOUNTS IN THE EASTERN MEDITERRANEAN SEA

Bayram Öztürk [1]*, Eda N. Topcu [1] and Bülent Topaloglu [1]
[1] Istanbul University, Fisheries Faculty, Ordu cad. No 200. Laleli, Istanbul – Turkey / Turkish Marine Research Foundation (TUDAV) P.K: 10 Beykoz, Istanbul - Turkey - ozturkb@istanbul.edu.tr

Abstract
Two seamount plateau were sampled which are very little known in terms of deep sea habitat in the Eastern Mediterranean Sea. A total of 11 fish, 7 crustaceans and a cephalopod species were found between 880-1107 m depths. *Galeus melastomus* and *Squalus acanthias* were common species for fish and *Aristaeomorpha foliacea* inboth seamount areas for crustaceans.
Keywords: Eastern Mediterranean, Deep Sea Ecology, Biodiversity

Introduction
In 2006-2007 and 2008, a three year survey was conducted in the Eastern Mediterranean Sea to better understand deep and high sea marine biodiversity. Samplings were performed by beam trawl in two locations in Eastern Mediterranean Sea. Finike Seamount were sampled at depths ranging from 880 to 1000m depths and Turgut Reis Seamount between 989 to 1107m depths in August 2008 period (Fig 1). Beam Trawls were conducted for sampling with a speed kept at 2,5-2,7 knots and lasted 30 minutes. The opening of net was 21.6 m with a mesh size of 22 mm. Samples were kept in Formalin.

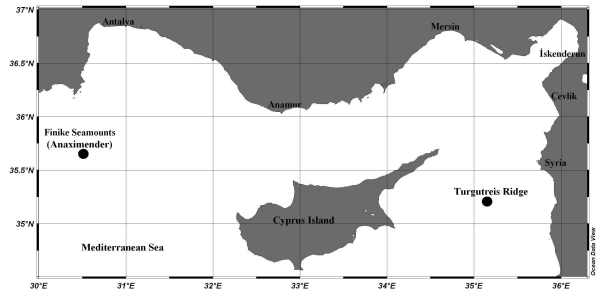


Fig. 1. Map of the Eastern Mediterranean with locations of sampling stations.

Results and Discussion
A total of eight fish species, four crustaceans and a cephalopod species were found in Finike Seamount (Anaximander Seamounts) (Table 1). Majority of these fish were deep sea fishes. All crustaceans also known as deep sea decapods and *P.longirostris* and *A.foliacea* were commercially important species in the eastern Mediterranean Sea. *A. veranyi*, also a deep sea cephalopod, is a preferable prey of the striped and Risso's dolphins [1]. Mud volcanoes with a methane cold seeps community were reported from this area and this community is unique and quite different from all other known cold seep communities in that location [2]. This fragile ecosystem is under the threat of mainly bottom trawling. In Turgut Reis Ridge, only three fish and three crustacean species were found. All crustacean species were also of commercial importance (Table 1). Turgut Reis Ridge was also important in terms of deep sea fishes and crustaceans. This area is also under the threat of bottom trawling. Our suggestion is to designate this two sensitive seamount areas as high sea marine protected area or sensitive deep sea habitats such as Eratosthenes Seamount which is decided by GFCM recommendation 30/2006/3 that no fishing activities any more [4]. Ichthyofaunal richness is correlated with the intensity of research in the Eastern Mediterranean Sea [3]. More detailed and long term study is needed for the protection of these unique habitats in the Eastern Mediterranean Sea

Tab. 1. List of fishes and invertebrates sampled in the Finike (Anaximander) and Turgut Reis Seamounts.

Finike Seamounts (Anaximander)		Turgutreis Ridge	
Family	**Species**	**Family**	**Species**
Pisces		**Pisces**	
Scyliorhinidae	*Galeus melastomus* (Rafinesque, 1810)	Scyliorhinidae	*Galeus melastomus* (Rafinesque, 1810)
Delatiidae	*Etmopterus spinax* (Linnaeus, 1758)	Squalidae	*Squalus acanthias* (Linnaeus, 1758)
Squalidae	*Squalus acanthias* (Linnaeus, 1758)		
		Phycidae	*Phycis blennoides* (Brünnich, 1768)
Nettastomatidae	*Nettastoma melanurum* (Rafinesque, 1810)	**Crustaceans**	
Trachichthyidae	*Hoplostethus mediterraneus* (Cuvier, 1829)	Pandalidae	*Plesionika martia* (A. Milne-Edwards, 1883)
Macrouridae	*Hymenocephalus italicus* (Giglioli, 1884)	Aristeidae	*Aristaeomorpha foliacea* (Risso, 1827)
Congridae	*Rhynchoconger trewavasae* (Jordan & Hubbs, 1925)	Aristeidae	*Aristeus antennatus* (Risso, 1816)
Ophidiidae	*Ophidion barbatum* (Linnaeus, 1758)		
Crustaceans			
Polychelidae	*Polycheles typhlops* (Heller, 1862)		
Calocaridídae	*Calocaris macandreae* (, 1846)		
Penaeidae	*Parapenaeus longirostris* (Lucas, 1846)		
Aristeidae	*Aristaeomorpha foliacea* (Risso, 1827)		
Cephalopod			
Teuthidae	*Abralia veranyi* (Rüppell, 1844)		

.

Acknowledgements: Authors thanks to Dr. D. Golani for the identification of fish samples. Support from East-Med Turkey project fund of I.U. Fisheries Faculty is acknowledged.

References
1 - Öztürk B., Tonay A., Öztürk A.A. and Dede A., 2007. Cephalopod remains in the diet of striped dolphins (*Stenella coeruleoalba*) and Risso's dolphins (*Grampus griseus*) in the eastern Mediterranean Sea. *Vie et milieu*. 57, (1/2): 53-59.
2 - Medioni F.A. 2003. Sources of energy for deep sea benthos in Mediterranean mud volcanoes. *CIESM.Workshop, Mon.* no. 23, p.77-80.
3 - Goren M. and Galil B.S. 2007. Is the Eastern Mediterranean a deep-sea desert? *Rapp. Comm. int. Mer. Medit.*, 38.
4 - Http://www.gfcm.org/gfcm/topic/16100/en

THE CHRONICLE OF ALIEN SPECIES IN DODECANESE ISLANDS: A PATHWAY OF INTRODUCTION IN EUROPEAN COASTAL WATERS

Maria-Antonietta Pancucci-Papadopoulou [1]* and Maria Corsini-Foka [1]
[1] Hellenic Centre for Marine Reasearch - apan@ath.hcmr.gr

Abstract
Alien species introduction was analysed from its starting in one of the hot-spot region of the Mediterranean Sea. Their impact is also discussed.
Keywords: Eastern Mediterranean, Biodiversity, Species Introduction, Aegean Sea

Our attention focuses on the Dodecanese Islands, as it is the closest to the coast of Asia Minor Hellenic area and the easternmost European waters significantly affected by the so called "biological pollution". Of the 192 alien species currently known from Greek Seas [1], 86 (44.8%) occur along the Dodecanese coasts, almost all (84) from warm/tropical waters: 6 by shipping, 3 by unknown vector, 1 via Dardanelles, 3 via Gibraltar and 71 via the Suez Canal (Fig. 1).

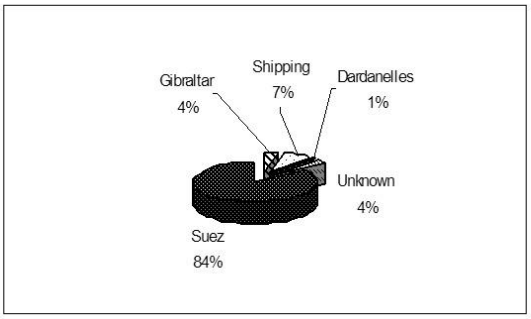


Fig. 1. Pathway of introduction

The first two lessepsian migrants were evidenced in Rhodes Island in 1894, the seagrass *Halophila stipulacea* and the macroalga *Hypnea cornuta*. Almost 40 years later (1930's) 3 Indo-Pacific fish species were recorded in the area, followed by other 5 during the 1940's. The first one, *Siganus rivulatus*, rapidly acquired commercial value. Thus, the corridor was open and changes in native communities and fishery activities started. During 1950's the first benthic invertebrate was recorded. A huge increase of alien species has been observed from the beginning of 1980s, after almost a century of "smooth" colonisation (Fig. 2).

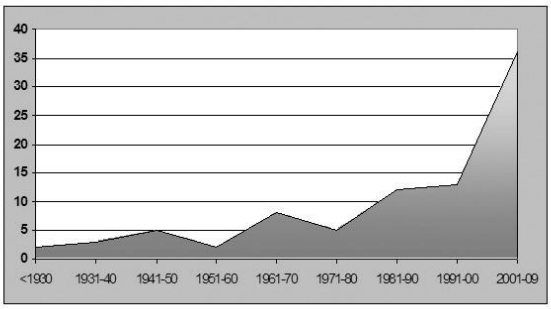


Fig. 2. Trend of introduction

It must be noticed that this increase parallels the observed warming of the area, which showed an abrupt shift by the end of 1990's, resulting to more favourable conditions for the establishment of alien species. A strong correlation between alien species entry and climate warming has been detected [2]. During the 1980's the alien biota was increased by 2 polychaetes, 6 planktonic, 3 fish species and 1 gastropod (*Strombus persicus*, 1986), which quickly invaded all sandy bottoms of the Island. From then towards the introduction of alien species in the area assumed the character of invasion, with the addition of 13 new species during the 1990's and 36 from 2001 to 2009! Zoobenthos (38%) and fish (37%) are the most important groups, followed by phytobenthos (17%) and plankton (phytoplankton 6%, zooplankton 2%). The most evident effects of new species entry can be detected at three different levels: biodiversity, economy and human health. Until now, evidence for endangerment or extinction of native species in the study area has not been detected, although this does not mean that it may not have occurred or may not be occurring. However, the 32 alien fish present (28 of Indo-Pacific and 4 of Atlantic origin), almost all well established, constitute approximately the 10% of the total ichthyofauna diversity [3]. From an economical point of view, few introduced species are locally exploited (*S. persicus*, *S. rivulatus*, *S.luridus*, *Sphyraena chrysotaenia*, *Etrumeus teres*) and recent colonizers (*Sepioteuthis lessoniana* and *Upeneus pori*) show a rapid increase. *Fistularia commersonii*, a piscivorous fish abundant and seriously affecting native species, is not appreciated, thus discarded. An example of invasive species provoking damages to biodiversity, economy and human health is the toxic fish *Lagocephalus sceleratus*, which evidences the huge dimension of the problem worldwide. The gradual tropicalization of the Mediterranean and the higher resistance to natural changes of tropical compared to native species lead us to believe that alien tropical species, now mostly affecting the Eastern basin, will gradually colonize the rest of the Mediterranean.

References
1 - Zenetos A., Pancucci-Papadopoulou M.A., Zogaris S., PapastergiadouE., Vardakas A, L., Aligizaki K. and Economou A.N., 2009. Aquatic alien species in Greece (2009): tracking sources, patterns and effects on the ecosystem. *J.Biol. Res.*-Thessaloniki, in press.
2 - Pancucci-Papadopoulou, M.A., Corsini-Foka, M. and Raitsos D.E., 2009. South Eastern Aegean: a testbed for biological invasions and ecosystem functioning changes. BIOLIEF, Porto, 27-30/10/2009: 44.
3 - Corsini-Foka, M., 2009. Uncommon fishes from Rhodes and nearby marine region (SE Aegean Sea, Greece). *J.Biol. Res.*-Thessaloniki, in press.

GROWTH RATES OF EARLY LIFE STAGES OF *ENGRAULIS ENCRASICOLUS* AND *SARDINA PILCHARDUS* IN THE ADRIATIC SEA (ITALY)

Monica Panfili [1]*, Fortunata Donato [1], Elisabetta Betulla Morello [1] and Enrico Arneri [1]
[1] ISMAR-CNR Sez. Pesca Marittima, Largo Fiera della Pesca, 60125 Ancona, Italy - m.panfili@an.ismar.cnr.it

Abstract
Early life stages of anchovy and sardine were collected in the Adriatic Sea during three seasonal surveys carried out between June 2007 and February 2008. Growth rates were estimated by daily increment counts on sagittal otoliths. Age estimates were made on late-larvae specimens, just before the transition from larval to juvenile stage. Growth of these vulnerable stages may be an important factor affecting recruitment success.
Keywords: Adriatic Sea, Pelagic, Larvae, Growth, Fishes

Introduction
Small pelagic fishes, especially anchovy *Engraulis encrasicolus* and sardine *Sardina pilchardus*, are important species in the Adriatic Sea, from both ecological and socio-economic points of views [1]. A major gap in the management of small pelagic fish stocks in the Adriatic Sea as well as in the whole Mediterranean Sea, is the limited knowledge of the basic aspects of early life stages. The stock biomass depends primarily on the strength of recruitment and on the survival/viability of early life stages. Consequently, knowledge regarding growth rates of the vulnerable stages in these pelagic species may be useful to understand the factors affecting year class strength and subsequent biomass of the adult population, as well as being essential for management purposes.

Materials and Methods
Three seasonal surveys of anchovy and sardine late-larvae were carried out between June 2007 and February 2008 by means of a pelagic trawl (mesh size 5 mm stretched) in two nursery areas along the Adriatic coast (off the Po river and in the Gulf of Manfredonia). In the laboratory, late larvae were measured to the nearest mm below (standard length, SL) and weighed with an accuracy of 0.01 g (TW). Sagittal otoliths preparation and interpretation procedures are described in [2]. The growth rates of sardine and anchovy late larvae were estimated by fitting linear regressions to the whole age-length dataset, as follows: SL = a+ b*age (days) where a would be the fish standard length at age 0 (i.e. the estimated length at exogenous feeding when the first increment is laid down) and b is the instantaneous growth rate of juvenile anchovy. Moreover, the allometric length - weight relationships were calculated for both species applying a non-linear regression: $TW = a*SL^b$. For anchovy, growth rates (mm·day^{-1}) and SL–TW relationships obtained in the two sampling periods (June and November) were compared, over a common size range (11 – 38 mm SL), by means of Analysis of Covariance (ANCOVA).

Results and Discussion
Anchovy larvae were collected in June 2007 (n = 50) in the Gulf of Manfredonia and in November 2007 (n = 78) off the Po mount. The June sample consisted of a slightly wider size range (SL: 7-38 mm) than in the November sample (SL: 11-40 mm). Sardine late larvae were caught in February 2008 only (n = 78) and SL ranged from to 18 to 35 mm. The relationship between standard length (SL) and age (days), obtained for the two species, are shown in Fig. 1 and 2.

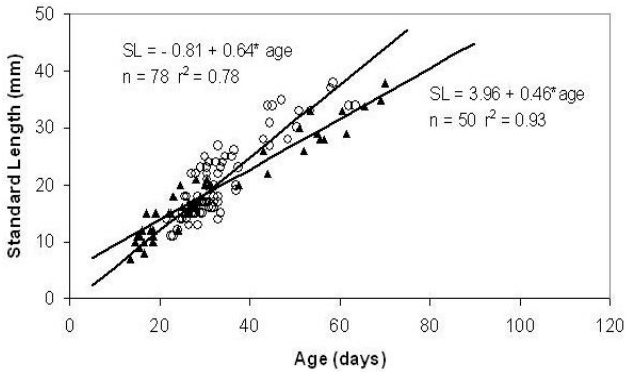


Fig. 1. Age-SL relationship estimated for anchovy late larvae collected in June'07 (triangle) and November'07 (circle)

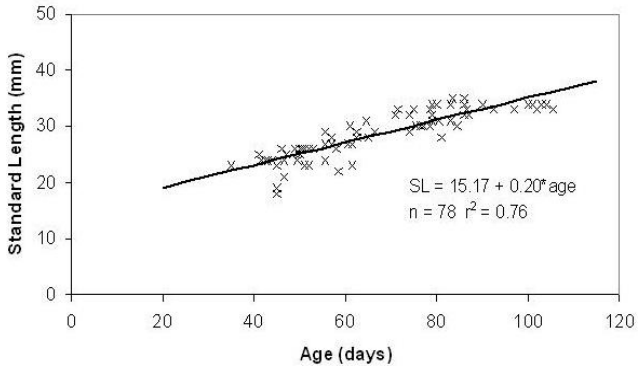


Fig. 2. Age-SL relationship estimated for sardine late larvae collected in February'08

The relationship SL-TW were described by the following equations: $TW = 1.51*10^{-06}SL^{3.43}$, $r^2 = 0.98$ for June anchovy; $TW = 7.93*10^{-07}SL^{3.56}$, $r^2 = 0.94$ for November anchovy and, $TW= 3.81*10^{-07}SL^{3.78}$, $r^2 = 0.84$ for sardine. The instantaneous growth rate estimated for sardine late larvae (0.20 mm·day^{-1}) was lower than those estimated for anchovy (0.46 and 0.64 mm·day^{-1} in June and November, respectively). Length-at-age of anchovy caught in November were significantly higher than those collected in June ($F = 20.97$; $p<0.001$) whilst no significant differences were found for growth-in-weight ($F = 1.50$; $p = 0.22$). These results obtained for anchovy partially disagree with the general pattern observed in another Adriatic area (Ortona) where the instantaneous growth rate picked in May and decreased in August and November [3]. Seasonal changes in environmental and trophic conditions largely affect instantaneous growth rate, indicating that the environment (e.g. food availability) was more favourable off the Po river mouth. Positive effects of temperature and food on the growth of fish are well documented [4], and in the case of anchovy the higher growth rate in November is probably related to trophic rather than temperature changes.

References
1 - Morello E.B., Arneri E. 2009., Anchovy and Sardine in the Adriatic Sea - An Ecological Review. *Oceanography and Marine Biology: An Annual Review*, 47: 209-256.
2 - Morales-Nin B., Aldanondo N., Álvarez I., 2010. Age determination of larval and juvenile small pelagics: The importance of a common protocol. 39TH CIESM Congress, Venice, Italy, 10-14 May.
3 - La Mesa M., Donato F., Giannetti G., Arneri E., 2009. Growth and mortality rates of European anchovy (*Engraulis encrasicolus*) in the Adriatic Sea during the transition from larval to juvenile stages. *Fisheries Research*, 96: 275–280.
4 - Santojanni A., Arneri E., Bernardini V., Cingolani N., Di Marco M., Russo A., 2006. Effects of environmental variables on recruitment of anchovy in the Adriatic Sea. *Climate Research*, 31: 181-193.

ASPECTS OF ARTISANAL FISHERY IN THE NATIONAL MARINE PARK OF ALONNISOS - HELLAS

A. Papadopoulos [1]*, P. Vidoris [1], A. Kalianiotis [1], E. Tounda [2] and E. Joseph [2]
[1] Fisheries Research Institute - apapadop@inale.gr
[2] Mom

Abstract

The National Marine Park of Alonnisos in Northern Sporades was the first designated Marine Park in Hellas and is currently the largest marine protected area in Europe (approximately 2.260 Km^2). Aspects of the regional artisanal fishery were examined during the LIFE MOFI program. CPUE values exhibit great seasonal variations. These differences result from the seasonal landings of tuna, albacore and bogue which are being fished in vast quantities. Three distinctive fishing seasons have been identified regarding the target species**.** The main target species of the artisanal fishery was *B. boops*.

Keywords: Fisheries, Marine Parks, Aegean Sea

Introduction

During the LIFE MOFI program field work has been conducted in order to accurately measure the actual intensity of seal-fishery interaction aboard local professional artisanal fishing boats in the National Marine Park (N.M.P.) of Alonnisos in Hellas. The purpose of this paper is to describe aspects of synthesis, effort, and seasonality of the artisanal fishery fleet within the area of the national marine park.

Materials and Methods

The work plan included the collection of 15 landings data of coastal fishery vessels per month for a period of two years which started in May 2006 and ended in May 2008. Discards were not included. All the sampling cruises took place in the waters within the park. For the grouping of coastal fishery and the evaluation of target species per month, CPUE values from all gears (kg/vessel/day) per species were used. The non parametric Kruskal-Wallis ANOVA by Ranks test was used to test for differences between monthly CPUE values. Cluster analysis was based on Bray-Curtis similarity indices on thirty species that their frequency of occurrence cumulatively counts for more than 90%. The species, which primarily account for the observed differences between fishing seasons, were defined by SIMPER routine.

Results and Discusion

During the survey, 355 interviews of boat owners were obtained and consist data for landed species. In total, 48 species were of commercial value in the local landings. However, 10 species dominate the catches and these account for 92,1% of the total quantity landed. Of these, 70,7% is represented by 3 species, namely *B. boops (33,5%)*, *T. alalunga (24,2%)* and *T. thynnus (13,2%)*. Seven species represent 21,3% of the total catches namely *P. elephas* (6,7%), *M. merluccius* (4,3%), *P. pagrus* (3,6%), *Scorpaena sp*. (2,2%), *M. surmuletus* (1,8%), *L. piscatorius* (1,4%), and *P. phycis* (1,1%).

The remaining 38 species consist of 8,1% of the total catches. The total CPUE (kg/day/vessel) from all gears, fluctuated between 11,8 kg/day/vessel in June and 125 kg/day/vessel in December for the period May 2006 – May 2007. For the fishing season June 2007- May 2008 CPUE values fluctuated between 16,8 kg/day/vessel in June and 177 kg/day/vessel in November.

Concerning the total CPUE, for the two fishing periods the non parametric Kruskal-Wallis ANOVA by Ranks test, indicates that there is statistical difference between months for the median CPUE values (H= 90.99 and p =0.000) for the period 2006-2007. There are also differences for the period 2007-2008 (H= 71.692 and p =0.000).

Outliers and extreme values were not often recorded for both fishing seasons. When they do these values are associated with the fishing of *T. thynnus* and *T. alalunga* which gives heavy animals and *B. boops* a species that gives large catches. However, lobster and hake fishing were responsible for some outliers. In Alonnisos, however, the daily catches considered to be highly influenced by both environmental and/or biological factors, concerning that the ability of the skippers was the same thought out the year.

Cluster analysis (fig. 1) indicated three groups of fishing seasons. The first fishing season consisted of the autumn months with the addition of December 2007. The second fishing season consisted the winter months of January and February of the years 2006-2007, and the third fishing season spring and summer months of the same years.

Simper analyses indicates a 58,41% average similarity for the first fishing season with *B. boops* (19,9%), *T. alalunga* (19%), *T. thynnus* (13,6%) primarily account for the observed similarity. The second fishing season indicates a 67.97% average similarity. *B. boops* (24%), *L. vulgaris* (14,3%), *S. maena* (13,7%) and *P.pagrus* (13,2%) are mainly responsible for 65,2% of the observed average similarity. The third fishing season indicates a 65,21% average similarity with *P. elephas* (10,8%), *B. boops* (9,7%), *P. pagrus* (9,6%) and *Scorpaena sp*. (8,9%).

According to these results for all three fishing season, the main target species was *B. boops*. However important differences appear regarding seasonal differentiations. During the autumn months (Season 1) the fleet is focusing its efforts to the fishing of *T. thynnus* and *T. alalunga*, both seasonal catches in the area. During winter months (Season 2) the fleet is targeting mainly *B. boops*. Other species were considered either as accidental catches or occasionally targeted species by the fleet. During spring and summer months (Season 3) the fleet is diversifying the number of target species shifting on the fishing of more common coastal species in the area.

Such data provides a useful insight to regional fishing practices and contribute to determine conservation strategies and effective management measures that could be implemented for the preservation of the area.

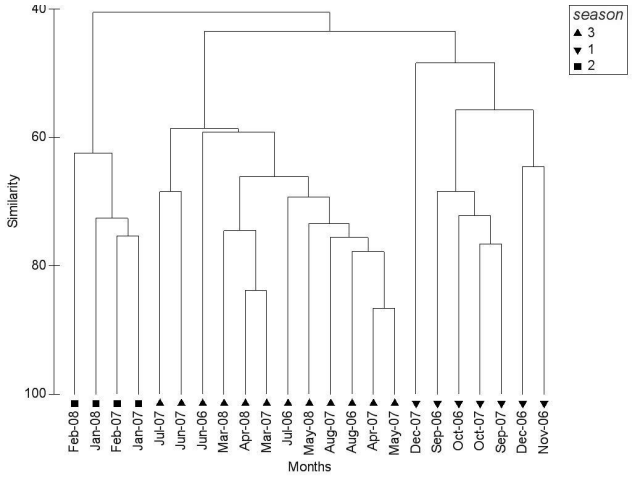


Fig. 1. Dendrogram of similarities for fishing periods in the N.M.P. of Alonnisos in Hellas

References

1 - Clarke, K. R. and R. M. Warwick., 1994. Changes in marine communities: an approach to statistical analysis and interpretation. Natural Environment Reshearch Council, UK.

2 - Fishcher W., Bauchot M.L, Schneider M., (redacteurs)., 1987. Fishes FAO d' identification des especes pour le s besoins de la pesce (Revesion 1). Mediterranee et mer Noir. Zone de pesce 37.2. Vertebres. Publication prepare par la FAO (Project GCP/INT/442/EEC). Rome, FAO: 1-1533.

MEGAFAUNAL ASSEMBLAGES IN THE DEEP WATERS OF THE NORTH AEGEAN SEA (HELLAS)

Anastasios Papadopoulos [1]*, Pavlos Vidoris [1] and Argyris Kalianiotis [1]
[1] Fisheries Research Institute - apapadop@inale.gr

Abstract

The annual summer changes of the megafaunal assemblages from 6 sampling stations in the deep waters (>500m) of north and central Aegean Sea were studied for the period 2003-2006. Geographical differentiations occur both in the composition and species diversity between stations in the north and central part of the Aegean sea. These differences are attributed to the different geographical positions and the general oceanographic and circulation features of the areas.

Keywords: Deep Waters, Aegean Sea, Biodiversity

Introduction

During the MEDITS program, annual bottom trawl surveys are conducted mainly from late spring to mid summer in the Mediterranean, in depths ranging from 10-800 m, in order to obtain estimates of abundance for a series of target species. However, little attention has been paid to the diversity and abundance of species and their relative assemblages in waters deeper than 500 m. The aim of this work is to describe aspects of the species assemblages and the biodiversity in the deep waters of the north and central Aegean Sea.

Materials and Methods

Samples from 6 stations in the depth zone of 500-800m were collected during the four years period 2003-2006 through MEDITS program. Standard net GOC 73 having a cod end mesh opening of 20mm (stretched) was used. For data analysis, the sampling year was noted as 3 for 2003, 4 for 2004, 5 for 2005 and 6 for 2006. All 6 stattions have depths between 500 and 600 m. Two of the stations (10 & 12) were located in Lemnos basin, one in Skyros basin (30), one between Skyros and Chios basins (28) and two in Chios basin (24 & 25). Catches of fish were identified to species levels for each haul. Cluster analysis was performed with PRIMER routine [1] using data transformed with Bray–Curtis similarity index. The differences between stations and the species responsible for the calculated differences were based on ANOSIM and SIMPER respectively. Biodiversity index was calculated using Shannon index.

Results

During the four years of sampling in these 6 stations, 3025 individuals were fished which belonged to 93 species. Of these 69 were fishes, 12 were cephalopods and 12 were crustaceans. Non-metric multidimensional scaling (MDS) ordination indicates that the stations were grouped based on their geographical position (Fig.1).

Statistical analysis indicated two groups that differed among them. Stations 10, 12, 28 and 30 constitute one (North) group and stations 24 and 25 the other (Central) group (ANOSIM: R global >0,75, p=0,001).

Simper analysis showed that five species are mainly responsible for the grouping of the North stations and these are *L. crocodilus, P. martia, N. sclerorhynchus, T. scabrous, A. hemigymnus, and L. dofleini* (Total contribution 72,88%).

Eleven species are responsible for the grouping of the Central group stations, *C. agassizi, C. caelorhincus, H. italicus, L. dofleini, P. longirostris, M. punctatum, H. mediterraneus, T. sagittatus, P. blennoides, P. cataphractum, N. norvegicus* (Total contribution 70,52%).

The average dissimilarity between the two groups is 78,78% with 23 species contributing 70,34% to that differentiation *C. agassizi, C. caelorhicus, T. scabrus, L. crocodilus P. martia B. glaciale H. italicus L. dofleini P. longirostris M. punctatum P. heterocarpus G. argenteus N. sclerorhynchus A. hemigymnus H. mediterraneus P. cataphractum P. sivado T. sagittatus S. veranyi P. blennoides N. norvegicus D. metopoclampus H. dactylopterus, G. melastomus.*

The Shannon Winner diversity index was calculated based on the abundance of each species for each one of the stations during the four sampling periods. Values of the index for the North group fluctuated between 1,640 and 2,839 and between 2,821 and 3,420 for the Central group during the four years of sampling. The fluctuation of the index values indicates a differentiation in the biodiversity both between the groups as well as within the groups during the years of sampling.

These differences in assemblages and diversity may be attributed to the characteristics of the deep water that has been accumulated in each of the North–Central Aegean basins and vary according to the different geographical positions of each basin with respect to the formation sites and the general circulation features of the Aegean [2]. The same authors suggest that Lemnos and Skyros basins show almost identical behaviour.

The water volume below 500 m is almost the same for these two basins, they probably share the same physical characteristics and that is why they support the same species assemblages.

On the other hand, Chios basin is by far the most prone to change. This must be attributed to its position. The major water exchange between the northern and southern parts of the Aegean take place over the Chios basin. Dense waters of high salinity and low temperature that filled the deepest parts of Chios basin, alter their characteristics through vertical diffusion as they mix with warmer and less saline intermediate waters [2].

This phenomenon over the Chios basin probably creates an environment that can favour a larger number of species with more diverse ecological attributes and that explains the higher values of Shannon diversity index. In summary, since assemblages in the north part of the Aegean Sea were always less diverse than the assemblages in the central part of the Aegean sea we assume that the composition of the communities reflect the ecological conditions at the two parts of the Aegean.

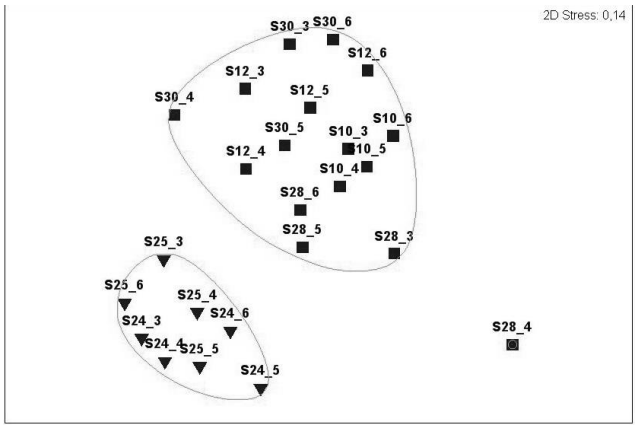


Fig. 1. MDS plot for the sampling stations for all four years of sampling based on abundance. Squares - Stations in Lemnos & Skyros basins, Triangles- Stations in the Chios Basin

References

1 - Clarke K. R. and Warwick R. M., 2001. Changes in marine communities: an approach to statistical analysis and interpretation 2nd edition. *PML*. UK.

2 - Valaoras D. and Lascaratos A., 2005. Deep water mass characteristics and interannual variability in the North and Central Aegean Sea. *Journal of Marine Systems* 53, 59–85.

NEW DATA ABOUT POLYCHAETA COMMUNITIES FROM THE ST. GEORGE–VADU, ROMANIAN BLACK SEA LITTORAL ZONE

Gabriela Paraschiv [1]*

[1] "Ovidius" University Constanza, Romania - gm_paraschiv@yahoo.com

Abstract

Based on a number of 449 collected samples, from a 0-28m-depth interval, from the St. George-Vadu Romanian segment of the Black Sea littoral, the main types of sedimentary habitats were identified and the characteristic Polychaeta associations. Dominant are the clay habitats, occasionally mixed with silt, in which populations of the following species can be found: *Melinna palmata* (from a depth of approx. 10m) *Euclymene collaris* and *Heteromastus filiformis* (from a depth of approx. 4m). The 1970s bibliography cites in these habitats, the *Nephthys hombergii* silt enclave.

Keywords: Black Sea, Polychaeta, Sediments

Introduction

The littoral segment St. George-Vadu represents an area of interest as it is directly influenced by the Danube and it includes dynamic sedimentary and erosion processes. The benthal communities are structured based on their affinities for one type of sedimentary habitat or another and based on the particular conditions of the life environment (hydrodynamic water mass, food resources). The Polychaeta group is well represented on all benthic biotopes on the NW Black Sea shelf, from the shallow water bottoms to the lower limit of benthic life (for Black Sea - the periazoic belt). This study was possible through the research program of the Project CERES 4-174/November 2004: The integrated geophysical-geoecological investigation of the St.George-Vadu littoral sector", accomplished by us in collaboration with INCD–GEOECOMAR, Bucharest.

Material and Methods

The quantitative samples collection started with August 2005 and 2006, at depth intervals of 0-28m, by means of Van Veen bodengreifer devices (surface 18x22cm). Based on the 449 quantitative samples, collected randomly, Polychaeta species were identified and a database set up. The ecological indexes for dominance and frequencies were calculated for different types of habitats. The granulometric analysis for fraction determination was realized according to the standard sedimentological method and the limits of the granulometric categories are: the sand/silt limit-0.063mm and the silt/clay limit-0.04mm (Wentworth method).

Results and Discussion

The structure of polychetes community from different habitats, after some authors it is considered to be an instrument that characterized local particularities linked to the benthic sub-layer habitats while other authors considered that the depth and the dynamic of water masses influenced this structure on a much larger scale than other factors. Keeping in mind the synergic action of these factors (benthic sub-layers and bathymetric) we have followed the structure of the Polychaeta community after particulars habitats from our research area: the first, in front of Danube Delta (St. George branch-Sacalin), second Sacalin Island–Portita and third Portita-Vadu. The littoral segment St. George-Vadu is characterized by an almost continuous disposition of the sediments habitats for the studied depth interval (0-28m). Still, various types of habitats are signaled, according to the dominant granulometric fraction (sand, silt, clay). Nearby the flowing mouth of the Danube/St. George branch, the benthal domain is dominated by the silt/clay habitats starting with the shallow zones (down to 25m). These compacted sediments at the basis of the sediment column (down to 20-25cm deep) display at the surface a slightly fluid layer with a significant percentage of detritus (particulate organic matter). This type of habitat was also found further south (Portita and Vadu) and in the sheltered area between shore and Sacalin Island (depths of over 10m). The list we drew up on the basis of the taken samples comprises a 28 Polychaeta species, 20 of which belong to the Palpata group (50% Spionidae and 25% Phyllodocidae) and the rest belong to the Scolecidae; a first analysis of this community indicates the detritivorous and suspensivorous as dominant. Scolecidae dominates the community of Polychaeta populations from clay substratum (8 species) from which 6 are Capitelidae: *Capitella capitata* (Fabr.), *Capitella minima* (Langerh.), *Capitellides giardi* (Mesnil.), *Capitomastus minimus* (Langerh.), *Heteromastus filiformis* (Clap.), *Notomastus lineatus* (Clap.). In the littoral sector between Sacalin Island and Portita, affected by a strong littoral current, the benthal domain (depths between 4 and 25-28 m) is dominated by mixed sediments – type NISIAR, while the Polychaeta community is dominated by Phyllodocidae (among which, *Nephthys hombergii* and the Nereidae species*: Nenthes succinea* or *Hediste diversicolor*. The Prisor-Vadu sector low depth shore (0-5m) is characterized by sandy sediments, that era generally compacted; the Polychaeta community is relatively poor (populated only by 5 species, Spionidae being dominant).

Conclusion

The qualitative and quantitative analysis of the polychetes communities reveal that important changes have occurred in the community in the last decades and we cannot help observing that the changes have been brought about by the proliferation of sedentary, detritivorous and/or deposit feeding species on the one hand and the reduction in predatory forms on the other hand. In this research area, St. George – Vadu littoral segment, the benthic zoocoenosis suffered an important restructuration processes with the naturalization of the newly-penetrated bivalve *Mya arenaria*, and with the increase in the number of dams in the hydrographic basin of the Danube, which also affected the Polychaeta populations. In the 1970s, the Polychaeta community in the Delta Danube front was dominated by the species *Nephthys hombergii* – "*Nephthys* sediments enclave", [1]. The studies accomplished in the 1980s [2], [3], [4] signaled the expansion tendency of the sedimentary habitats with *Melina palmate* towards the shore, a tendency also confirmed by our studies. South to Portita, in the infralittoral layer corresponding to 3-6m depth interval, a biocoenosis was cited (with fine sands) in which *Spio filicornis* was dominant. Our studies of the sandy sediments show that the population of *Spio* is limited to a narrow strip parallel to the shore, in the depth interval 1-4m. The sedimentary substratum with mixed sandy, silt and clay from south to Portita, the *Euclymene collaris* and *Heteromastus filiformis* populations registered a extension from depths lower then 10m in the `70 to the depth 4-6m in present.

References

1 - Bacescu, M., Müller,G.I.and Gomoiu M.-T.,1971. Benthal Ecological Research in the Black Sea; Qualitative, Quantitative and Compared Analyses of Pontic Benthal Fauna. In: *Marine Ecology*, 4; Ed. Romanian Academy, Bucuresti 357.

2 - Gomoiu, M.-T., 1982. On the populations of *Melinna palmata* GRUBE at the Romanian littoral of the Black Sea. *Cercetari Marine – Recherches marines* IRCM Constanta, Romania, 15: 115-131.

3 - Tiganus, V.,1982. Modifications dans la structure de la biocenose des sables a *Corbula mediterranea* (Costa) du littoral roumain. *Rapp.Comm.int.mer Medit*., 28: 205-206.

4 - Tiganus, V., 1988. Distribution des peuplements de Polychetes les plus frequents du secteur marin devant les embouchures du Danube. *Rapp.Comm.int.mer Medit.*, 31, *2*:23.

QUALITATIVE STUDY OF BENTHIC FORAMINIFERA IN THERMAIKOS GULF (N. AEGEAN SEA)

Effrosyni Parcharidou [1], Panagiotis Damianidis [1]* and Chariton-charles Chintiroglou [1]
[1] Department of Zoology, School of Biology - damian@bio.auth.gr

Abstract
The study of the benthic foraminifera assemblages in Thermaikos gulf (N. Aegean Sea) revealed the presence of 34 genera. The most abundant were *Ammonia, Quinqueloculina* and *Elphidium* which contributed to the 90% of the total 3,800 individuals. Their presence was particularly notable near the airport of Thessaloniki, where construction has disturbed the sediment and allowed the profusion of opportunistic species, though further investigation is required to confirm this assumption.
Keywords: Aegean Sea, Foraminifera

Introduction
Foraminifera are the most abundant protozoa in the marine ecosystems and they play an important role in global geochemical cycles of inorganic and organic compounds [1], [2]. Due to their sensitivity to pollutants and the subsequent modification of their assemblages, they have been widely used in studies as pollution-indicators over the last decades [3]. In the present study, the composition of the benthic foraminifera communities is recorded for the first time in Thermaikos Gulf (N. Aegean Sea, Greece), which is heavily influenced by urban and construction development. This study was part of a research project (Operational Programme for Fisheries Sector 2000-2006).

Tab. 1. List of foraminifera genera identified in Themaikos gulf (N=number of individuals, Am=mean abundance, Dmp=Partial mean dominance, P=number of samples in which genus was found, F=frequency of genus in the total of samples)

	Foraminifera genera	N	Am	Dmp	P	F
1	*Adelosina*	122	20,33	0,03	3	0,50
2	*Ammonia*	2428	404,67	0,64	6	1,00
3	*Amphistegina*	1	0,17	0,00	1	0,17
4	*Aurila*	1	0,17	0,00	1	0,17
5	*Bolivina*	2	0,33	0,00	1	0,17
6	*Cytherelloidea*	3	0,50	0,00	2	0,33
7	*Discorbinella*	2	0,33	0,00	1	0,17
8	*Elphidium*	387	64,50	0,10	4	0,67
9	*Fissurina*	1	0,17	0,00	1	0,17
10	*Gavelinopsis*	1	0,17	0,00	1	0,17
11	*Globobulimina*	2	0,33	0,00	1	0,17
12	*Globulina*	3	0,50	0,00	2	0,33
13	*Haynesina*	24	4,00	0,01	2	0,33
14	*Hyalinea*	5	0,83	0,00	1	0,17
15	*Lachlanella*	15	2,50	0,00	2	0,33
16	*Lagena*	1	0,17	0,00	1	0,17
17	*Lenticulina*	1	0,17	0,00	1	0,17
18	*Loxoconcha*	7	1,17	0,00	2	0,33
19	*Miliolinella*	1	0,17	0,00	1	0,17
20	*Osangularia*	1	0,17	0,00	1	0,17
21	*Peneroplis*	1	0,17	0,00	1	0,17
22	*Planorbulina*	1	0,17	0,00	1	0,17
23	*Pyrgo*	3	0,50	0,00	1	0,17
24	*Quinqueloculina*	586	97,67	0,15	6	1,00
25	*Rosalina*	63	10,50	0,02	4	0,67
26	*Sigmolina*	1	0,17	0,00	1	0,17
27	*Siphonaperta*	8	1,33	0,00	3	0,50
28	*Spirillina*	1	0,17	0,00	1	0,17
29	*Spiroloculina*	11	1,83	0,00	2	0,33
30	*Triloculina*	76	12,67	0,02	4	0,67
31	*Urocythereis*	1	0,17	0,00	1	0,17
32	*Xestoleberis*	10	1,67	0,00	5	0,83
33	unidentified 1	14	2,33	0,00	1	0,17
34	unidentified 2	16	2,67	0,00	2	0,33
	total	3800				

Material and Methods
Six sediment cores (4 cm diameter) were collected seasonally (Autumn 2007 – Spring 2008) from 3 different sites at the inner Thermaikos Gulf [St1: Paliomana, (N 40°36,332' E 22°52,816'), St2: Airport (40°31,812' E 22° 57,740') and St3: Karabournaki (N 40° 35,001' E 22° 55,563')], at depths from 4 to 8 m. Overall, 3,800 foraminifera individuals were identified, including dead ones, which comprised about 80% of the total number. The dead assemblages were also considered, as sampling took place biannually and, therefore, the thorough study of the short life and reproduction cycles of these protozoa was hindered [4]. All individuals were identified at genus level, with the exception of the most abundant, which was *Ammonia beccarii* (Linné). Kruskal-Wallis and Fisher's LSD tests were employed to examine differences in abundance between the three stations [5].

Results and Discussion
Overall, 32 foraminifera genera were identified from 3,800 individuals; two additional genera remained unidentified. The most abundant was *Ammonia*, represented by *A. beccarii*, which made up for the 64% of the total number of individuals. Another two genera, *Quinqeloculina* and *Elphidium* showed high frequency in the samples. These three genera contributed up to 90% of the total number (Table 1). In general, the most frequent genera in this study (>50%) are also very common in other parts of the Aegean Sea [6]. The Kruskal-Wallis test (22.81, $p<0.05$) and Fisher LSD showed that there is a significant difference between the abundance of foraminifera at St2 and the other two stations. This station is near the Airport of Thessaloniki where large reconstruction has been taken place and the sediment disturbance is significant. *Ammonia beccarii*, which is an opportunistic and pollutant tolerant species [1], [2], showed its largest abundance at this station, as did the other two abundant genera, *Quinqeloculina* and *Elphidium*. However, in order to utilize foraminifera as indicators of disturbance in the marine environment further investigation of their assemblages, at structural and functional level, is required [2].

References
1 - Alve E., 1995. Benthic foraminiferal responses to estuarine pollution: a review. *J. Foraminiferal Res.*, 25: 190-203.
2 - Yanko V., Arnold A. and Parker W., 1999. Effect of marine pollution on benthic foraminifera. *In*: Sen Gupta B.K. (ed.), Modern Foraminifera. Kluwer Academic Publ., Boston, pp. 217-235.
3 - Armynot du Chatelet E., Debenay J.-P. and Soulard R., 2004. Foraminiferal proxies for pollution monitoring in moderately polluted harbors. *Env. Pol.*, 127: 27-40.
4 - Frontalini F. and Coccioni R., 2008. Benthic foraminifera for heavy metal pollution monitoring: A case study from the central Adriatic Sea coast of Italy. *Estuarine, Coastal and Shelf Science*, 76: 404-417.
5 - Zar J.H., 1999. Biostatistical analysis. 4th edition. Prentice Hall, New Jersey, USA.
6 - Triantafyllou M., Tsourou T, Koukousioura O. and Dermitzakis M.D., 2005. Foraminiferal and ostracod ecological patterns in coastal environments of SE Andros Island (Middle Aegean Sea, Greece). *Rev. Mic*., 48: 279-302.

FISHERY ECOSYSTEM INDICATORS AND DYNAMICS IN THE MEDITERRANEAN FOR 1970-2005

Maria grazia Pennino [1]* and Jose maria Bellido [1]
[1] Instituto Español de Oceanografía. Centro Oceanográfico de Murcia - grazia.pennino@mu.ieo.es

Abstract
Though concerns about sustainability has been raised globally and ecosystem-based approaches have been proposed to manage fisheries, concepts such as "ecosystem health" and "ecosystem sustainability" are difficult to translate into operational objectives. The Large Marine Ecosystem approach can bring some light to this purpose, with the development of new ecosystem indicators to facilitate the understanding of the dynamics of the ecosystem. The "Mean Trophic Level" (MTL), the "Fishing Is Balanced" index (FIB), Pelagic/Demersal ratio (P/D) and the multispecies index of variability (SSD) are some of such indicators. These indices were utilised to examine the dynamics of the entire Mediterranean fishery ecosystem by analyzing the FAO database of fisheries landings from 1970 to 2005.
Keywords: Fisheries, Food Webs

Introduction and Methods
The present study aims to implement a LME approach in the Mediterranean Sea, that is one of the 64 Large Marine Ecosystems already identified [1]. The objective is to examine the Mediterranean fishery ecosystem in its whole in order to obtain an integrated insight of environmental and fishery issues. A priority to develop these new management strategies is to analize the dynamics and the changes occurring in the food chain over the time in the ecosystem. Therefore, there is a need for predictive indicators[2], which can be easily parameterised using easily accessible statistics [3]while communicating with a single number a variety of complex processes occurring within an ecosystem [4], such as those derived from the trophic level [5]. The study of MTL series of landings can describe the stages of exploitation of resources and analyze the state of the ecosystem relative to past periods for which there is no other data available except the amount of landings from fish markets [6]. In particular, according with others authors [7], in marine ecosystems, it would be possible to use the MTL of landings as an index of sustainability of the level of exploitation of fish resources and to analysis the phenomenon of the "Fishing Down the marine Food Webs" (FDFW) [6]. This is a gradual transition in landings from piscivorous, long-lived and high trophic level species to short-lived and low trophic level species as planktivorous pelagic fish and crustaceans and occurs because the species most susceptible to collapse are those of greater size with long life cycles, once these stocks will deplete, exploitation shall be directed toward smaller size species with a faster growth rate, and thus the mean trophic level of landings decreased [8]. We aim to examine the hypothesis of "FDFW" and changes in the Mediterranean ecosystem, analyzing FAO fisheries catches by 251 species from 1970 to 2005. The only analysis of the catch may not be sufficient to show the changes of the fishery ecosystem, but was accompanied by indicators such as: the Mean Trophic Level of landings (MTL), used to assess the effects of fishing activities at a ecosystem level, the "Fishing is Balanced" index (FIB), which allows to assess the stages of expansion or contraction of fishing pressure and bearing capacity exploited ecosystem [9], the ratio between pelagic and demersal organisms landed (P/D) which should provide information on the increase of nutrients in the basin and the multispecies index of variability (SSD) that show changes in the multispecies landings.

Results and Discussion
Mediterranean landings have increased from 300.000 in 1970 to 700.000 tonnes in 2005 with associated decrease of the MTL. In quantity terms, the proportion of the total marine fish landings which is accounted for by pelagic fish has risen from about 50% in 1970 to over 60% in 2005. The progression is remarkably sustained, possibly reflecting a shift in the fishery ecosystem. FIB index shows a negative trend in areas where landings and MTL decreases together, and a positive trends where there is increased fishing effort. The SSD index highlights that the abrupt increase in landings is accompained with major shifts in exploitation of target species. The P/D index shows a positive trend for all the years and in all divisions of the Mediterranean suggesting a clear predominance of pelagic on demersal fishes. Our analysis has revealed numerous ecosystem-level effects of fishing in marine ecosystems. We conclude that it is possible to conduct an innovative ecosystem assessment based on fishing resources in a system such as the Mediterranean Sea, characterized by high complexity and rather often low availability of information.

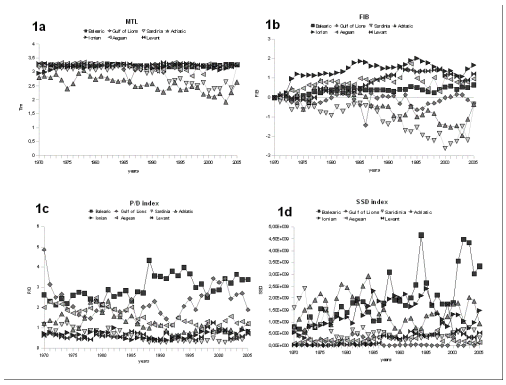


Fig. 1. Ecosystem indicators of Mediterranean GFCM divisions (1970-2005)



Fig. 2. Mediterranean Large Marine Ecosystem with GFCM divisions

References
1 - UNEP., 2005. LME Rep. A perspective on Changing Conditions in LMEs of the World's Regional Seas.
2 - Murawski, S.A., 2000. Definitions of overfishing from an ecosystem perspective. *ICES J. Mar. Sci.* 57: 649-658.
3 - Christensen, V., 2000. Indicators for marine ecosystems affected by fisheries. *Mar. Freshwater Res.* 51: 447-450.
4 - Pauly, D., Watson, R., 2004. Fisheries impact on global marine diversity and ecosystems: inferences from large heterogeneous data sets. Ocean Biodiversity Informatic 29 Nov.-1 Dec. 2004.
5 - Catanzano, J., Cunningham, S., 2000. On fishery status, the precautionary approach and sustainability: does a role exist for "trophic level" reference points? CIESM. Kerkyra, 26-30 July.
6 - Pauly, D., Christensen, V., Dalsgaard, J.P.T., Froese, R., Torres, F., 1998. Fishing down marine food webs. *Science*. 279: 860-863.
7 - Pauly, D., Palomares, M.L., 2000. Approaches for dealing with three source of bias when studying the fishing down marine food web phenomenon. CIESM Workshop Series. 61-66.
8 - Stergiou, K.I., Koulouris, M., 2000. Fishing down the food webs in the Hellenic Seas. CIESM Workshop Series. 73-78.
9 - Pauly, D., Christensen, V., Walters, C., 2000b. Ecopath, ecosim, and ecospace as tools for evaluating ecosystem impact of fisheries. *ICES J. Mar. Sci*. 57: 697-706.

FIRST RESULTS ON THE MATURITY OF THE LESSEPSIAN MIGRANT *LAGOCEPHALUS SCELERATUS* (GMELIN 1789) IN THE EASTERN MEDITERRANEAN SEA

Panagiota Peristeraki [1]*, George Lazarakis [1] and George Tserpes [1]
[1] Hellenic Center for Marine Research - notap@her.hcmr.gr

Abstract

Analysis of the gonadosomatic index (GSI) of 94 specimens of the lessepsian migrant *Lagocephalus sceleratus*, recently invated to the Mediterranean Sea, suggest that reproduction of the species in the Mediterranean occurs in summer. GSI values start increasing at a total length of about 30 cm.

Keywords: Reproduction, Eastern Mediterranean, Suez Canal

Introduction. The Lessepsian migrant *Lagocephalus sceleratus* (Gmelin, 1789), also known as silverstripe blaasop, is an Indo-Pacific originated pufferfish of the family Tetraodontidae. The species has been recently introduced in the Mediterranean Sea through the Suez Canal [1, 2, 3] and has established populations in the eastern Mediterranean [4, 5]. *L. sceleratus* maybe a source of food poisoning with a high associated risk of mortality, as it commonly contains tetrodotoxin (TTX). The toxicity of the fish specimens inhabiting the E. Mediterranean has been also confirmed by recent studies [6, 7].

Materials & Methods. In the present study monthly data on size and maturity for 94 samples of *L. sceleratus*, have been analysed. Generalized additive model techniques [8] were used to analyze variations in gonadosomatic index (GSI) and the relative importance of total length (TL) and month of capture, in explaining those variations. The choice of the most appropriate link function and error distribution was made on the basis of residual plots. A Gamma error structure model accompanied by a log-link function was found to be the most appropriate for the analysis of the data. Model fitting was accomplished by means of the "mgcv" package [9] under the R language environment [10].

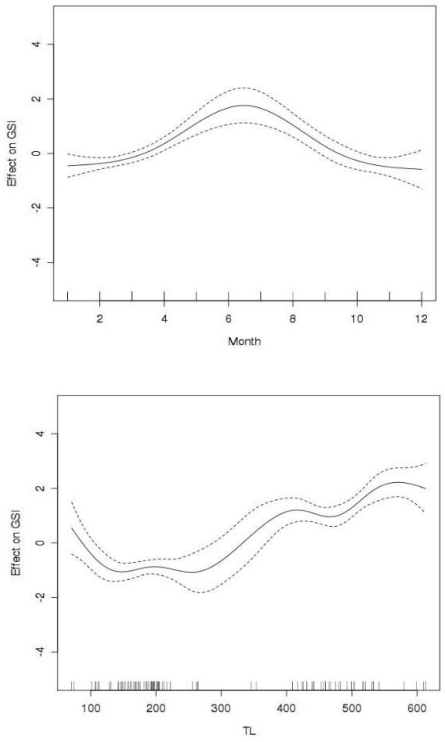


Fig. 1. GAM derived effects of total length (TL) and month on gonadosomatic index (GSI). Each plot represents the contribution of the corresponding variable to the fitted predictor. The fitted values are adjusted to average zero and the broken lines indicate two standard errors. The relative density of data points is shown by the "rug" on the x-axis

Results & Discussion. Analysis of deviance demonstrated that the effects of both the examined variables were highly significant ($p<0.01$). Plots of the standardized effects of the variables indicated that GSI starts increasing at a TL of about 30cm and reaches its maximum value around middle summer (Fig. 1). Those findings suggest that reproduction of the species in the Mediterranean occurs in summer.

References

1 - Akyol O, Unal V, Ceyhan T, Bilecenoglu M., 2005. First confirmed record of *Lagocephalus sceleratus* (Gmelin, 1789) in the Mediterranean. *J Fish Biol* 66: 1183-1186.

2 - Corsini M, Margies P, Kondilatos G, Economidis PS., 2006. Three new exotic fish records from the SE Aegean Greek waters. *Scientia Marina* 70:319-323.

3 - Kasapides, P., Peristeraki, P., Tserpes, G. and A. Magoulas., 2007. First record of the Lessepsian migrant *Lagocephalus sceleratus* (Gmelin 1789) (Osteichthyes: Tetraodondidae) in the Cretan Sea (Aegean, Greece). *Aquatic invasions*, 2: 71-73.

4 - Bilecenoglu M, Kaya M, Akalin S., 2006. Range expansion of silverstripe blaasop, *Lagocephalus sceleratus* (Gmelin, 1789), to the northern Aegean Sea. *Aquatic Invasions* 1:289-291.

5 - Peristeraki, P., Lazarakis, G., Skarvelis, K., Georgiadis, M., Tserpes, G., 2006. Additional records on the occurrence of alien fish species in the eastern Mediterranean Sea. *Mediterranean Marine Science*, 7: 61-67.

6 - Bentur Y, Ashkar J, Lurie Y, Levy Y, Azzam ZS, Litmanovich M, Golik M, Gurevych B, Golani D, Eisenman A., 2008. Lessepsian migration and tetrodotoxin poisoning due to *Lagocephalus sceleratus* in the eastern Mediterranean. *Toxicon* 52:964-968.

7 - Katikou P, Georgantelis D, Sinouris N, Petsi A, Fotaras T., 2009. First report on toxicity assessment of the Lessepsian migrant pufferfish *Lagocephalus sceleratus* (Gmelin, 1789) from European waters (Aegean Sea, Greece). *Toxicon* 54:50-55.

8 - Hastie, T.J. and R.J. Tibshirani. 1990., Generalized Additive Models. London: Chapman and Hall: 335 pp.

9 - Wood S.N., 2004. Stable and efficient multiple smoothing parameter estimation for generalized additive models. *J. Amer. Statist. Ass.* 99: 673-686.

10 - R Development Core Team., 2008. A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org

NOTE ON HISTORICAL AND PRESENT EXPLOITATION OF *CORALLIUM RUBRUM* (LINNEO, 1758) IN THE CENTRAL WESTERN MEDITERRANEAN

P. Pesci [1], R. Cannas [1], M. Follesa [1]*, C. Pedoni [1] and A. Cau [1]
[1] Department of Animal Biology and Ecology, University of Cagliari - follesac@unica.it

Abstract
The analyses of the landings and CPUE data from 1978 to 2005 for red coral in Sardinian seas (Central Western Mediterranean) were made. A statistical decrease in the landings can be observed. This reduction resulted very close to the decrease in the number of boats harvesting red coral. CPUE analysis at last allow to know that the average yearly amount of red coral landings by diver resulted steady with time.
Keywords: Cnidaria, Stock Assessment, Time Series, Western Mediterranean

Introduction
Red coral has been greatly exploited all over the Mediterranean Sea. The great exploitation of red coral made it a resource in danger according to many authors [1, 2, 3, 4, 5, 6]. Sardinia has a long history of red coral harvesting which led the adoption of a number of laws to manage this important resource. The most important rule established in 1989 in Sardinia (LR 30 maggio 1989, n. 23) banned the use of any towed gear to harvest red coral and imposed that only professional divers are allowed to pick up the coral manually. The aim of this work is then to evaluate if this resource in Sardinia has suffered overexploitation between 1978 and 2005.

Materials and Methods
The historical state of exploitation of the *Corallium rubrum* resource in Sardinian seas has been evaluated through the analysis of the data from FAO fisheries statistics. Yearly landings data (kg) from 1978 to 2005 were analyzed to find possible trends. Moreover, for the same period the analysis of the Catches per Unit of Effort (CPUE) has been made. The unit of effort here considered is the number of boats in which the "ingegno" was used for the period 1978-1989. The unit of effort in the following years is the number of divers manually harvesting the red coral. CPUE then represents the yearly mean of the red coral fished for unit of effort. Statistical trends were evaluated with the Spearman rank test [7].

Results and Discussion
FAO sources supply data for the red coral Sardinian landings from 1978 to 2005. A sharp decrease can be observed (Fig. 1). Spearman test indicates a statistically significant decreasing trend (P-value<<0.01). In fact from 1978 the data fall from more than 45000 kg to less than 5000 kg in 1990. After this 12 years decrease, however, a low steady state seems to be present (average of about 206 kg in the period 1989-2005).



Fig. 1. FAO landings data of *Corallium rubrum* for the sea around Sardinia (1978-2005)

This data alone however cannot be used as a sure assessment of a resource in danger. In fact if the number of boats used to harvest red coral is considered, a marked decrease of them can be noted. So the fishing effort has changed too with time and the decrease in the landed red coral does not necessarily indicate a decrease in its production. The CPUE can then be used to evaluate if the average of red coral landed by boats (or diver) has changed over time (Fig. 2).

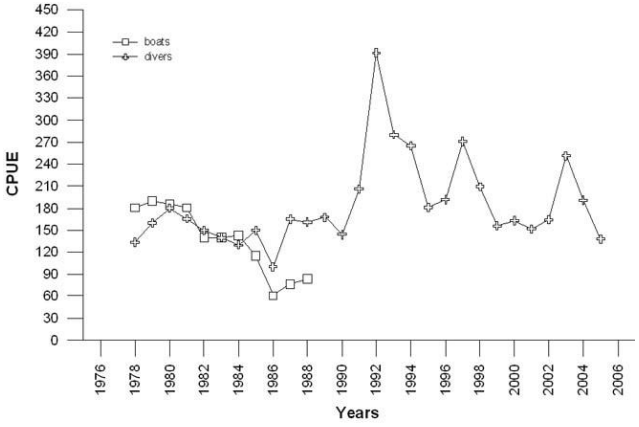


Fig. 2. CPUE (kg) of *Corallium rubrum* in the seas around Sardinia (1978-2005)

From 1978 to 1988 both the ingegno and the manually harvesting were made. The latter became the only way of pick up coral in Sardinia since 1989. A certain decrease in the CPUE relative to the boats can be observed, however, the data of the CPUE by diver show a steady state (mean value = 184 kg, P-value>0.05). The average amount of red coral landed by diver seems not to be decreased with time in the analysed period. These analyses show that the amount of red coral by diver stayed constant with time without decreasing as should be the case if an overexploitation of the resource is present. The regional laws seem to work in a good way for prevent the overexploitation of this resource in Sardinia.

References
1 - Tsounis G., Rossi S., Gili J., and Arntz W.E., 2006. Population structure of an exploited benthic cnidarian: the case study of red coral (*Corallium rubrum* L.). *Mar. Biol.* 149, 1059-1070.
2 - Morel J.P., Rondi-Costanzo C. and Ugolini D., 2000. Corallo di Ieri – Corallo di Oggi. Atti Del Convegno, Ravello, Villa Rufolo, 13-15 Dicembre 1996 Centro Universitario Europeo Per i Beni Culturali, Ravello. Edipuglia, Bari.
3 - Santangelo G. and Abbiati M., 2001. Red coral: conservation and management of an over-exploited Mediterranean species. *Aquatic. Conserv. Mar. Freshw. Ecosyst.* 1, 253-259.
4 - Santangelo G., Abbiati M., and Caforio G., 1993. Red coral fishing trends in the western Mediterranean Sea during the period 1981-1991. *Sci. Mar*. 57, 139-143.
5 - Food and Agriculture Organization (FAO)., 1988. GFCM technical consultation on red coral resources of the Mediterranenan. *FAO Fish. Rep.* 413, 1-159.
6 - Food and Agriculture Organization (FAO)., 1984. Technical consultation on red coral resources of the western Mediterranenan. *FAO Fish. Rep*. 306, 1-142.
7 - Zar J.H., 1996. Biostatistical analysis. Third edition. Prentice Hall, New Jersey.

TIME OF FISHING - AREA EFFECTS ON BOAT SEINE CATCHES IN GREEK WATERS

George Petrakis [1]*, Sandra Mosquera Montes [1] and Anna Cheilari [2]

[1] Hellenic Centre for Marine Research, Institute of Marine Biological Resources, Aghios Kosmas, Hellinikon 16610 Athens, Greece - gpetr@ath.hcmr.gr

[2] European Commission, Joint Research Centre (JRC); Institute for the Protection and Security of the Citizen (IPSC)-JRC.G.4. Maritime Affairs Unit, Via E. Fermi 2749 (TP 051), 21027 Ispra (Va), Italy

Abstract

Data from boat seine fishery in Greek waters have been analyzed to examine the effects of the time of fishing (before and after sunrise) and of the area on the catches. Data were collected on a monthly basis during the fishing period of the gear (10/2008-03/2009) in 14 different areas. The catch of *Spicara smaris*, the main target species of the gear, during hauls that took place before sunrise was 16%, whereas after sunrise was 48% of the total catch by weight. The catch of *Boops boops* and of all the "other species" before sunrise was 20% and 64% and after sunrise was 20% and 32%, respectively.

Keywords: Fisheries, Ionian Sea, Aegean Sea

Introduction

Boat seine is a traditional fishing gear which operates in the Greek waters. Now days, there are about 475 vessels with license, 400 of which are active [1]. The fleet is composed of rather small and old vessels. In 2008, the average age of the fleet was 44 years old and 84% of the vessels were smaller than 13 m. The main target species of the fishery are *Spicara smaris*, *Boops boops*, and *Sardina pilchardus* [1, 2]. According to the Greek legislation, fishing is allowed only during daytime, extending one hour before sunrise until one hour after sunset. Fish behavior differs on a daily cycle and consequently the quantity and the composition of the catch is affected by the time of fishing [3]. In this study the catch composition of boat seine fishery before and after sunrise in Greece was examined in order to investigate if differences in the catch due to the time of fishing could be used for managerial purposes.

Material and Methods

From October 2008 to March 2009, observers accompanied professional boat seine fishing vessels on a monthly basis in 14 areas around Greece. The observers without interfering with the fishing operations recorded the number, the weight and measured the lengths of all the species. In total, 239 hauls were sampled, 25 of them took place before and 214 after sunrise. In all areas, 30 different vessels were sampled. The contribution of *S. smaris*, *B. boops* and of all the "other species" in the total catch by number and by weight, before and after sunrise, was estimated combining all the areas. For the areas with observations before and after sunrise, the composition of the catch by weight was estimated as well. As "before sunrise hauls" were considered these hauls when more than 50% of the tow took place before sunrise.

Results and Discussion

A total of 490,990 individuals (466,732 after and 24,258 before sunrise) were caught, weighting 7,323 Kg (6,800 Kg after and 523 Kg before sunrise).The proportion of *S. smaris* in the catch of the hauls before sunrise was 16.4% (by weight) and 28.1% (by number), of *B. boops* was 19.8% (by weight) and 13.7% (by number) and of the "other species" 63.8% (by weight) and 58.2% (by number) (Fig. 1). During the after sunrise hauls, the proportion of *S. smaris* was 48.1% (by weight) and 64.7% (by number), of *B. boops* 20.0% (by weight) and 12.9% (by number) and of the "other species" 31.8% (by weight) and 22.4% (by number).

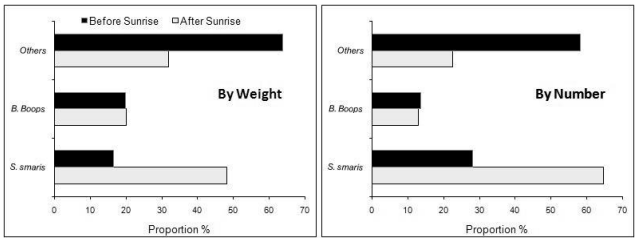


Fig. 1. Boat seine catch composition before and after sunrise by weight and by number in all areas.

The contribution of the "other species" to the total catch of the before sunrise hauls was higher than after sunrise, in all areas except Leykada (Fig. 2). In the latter, one of the main target species is *S. pilchardus* which was caught during the day. The contribution of *S. smaris* was higher in the after sunrise hauls in all areas except Lesvos. *B. boops* catch was higher in three areas before sunrise and in the other three after sunrise.

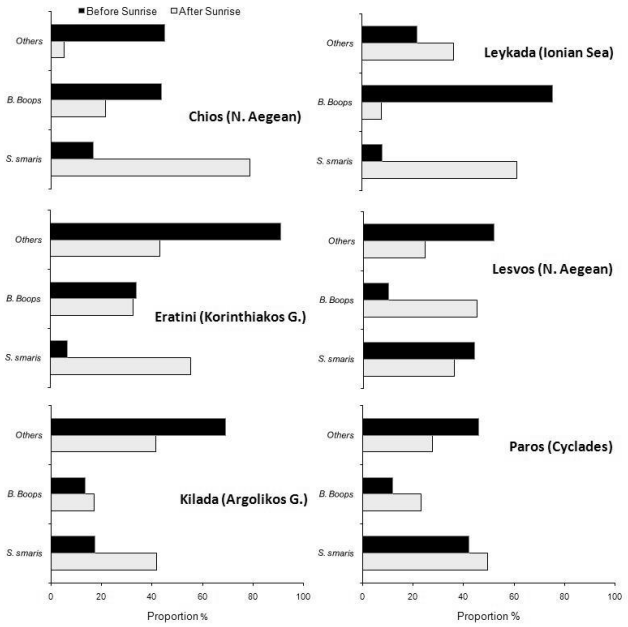


Fig. 2. Boat seine catch composition before and after sunrise by weight per area.

Boat seine fishery operates in coastal waters (maximum distance from the coast about 800 m according to the Greek legislation) using a mesh size of 16 mm in the cod-end, which is not size selective. However, each haul, takes place in a restricted area and only above appropriate bottoms. Consequently, the gear could operate in a species selective way in order to reduce the fishing mortality on the stocks of species like *Mullus spp., Pagellus spp., Diplodus spp.* According to this study, restriction of the time of fishing, during only daytime, could result in an important reduction on the catch of the "other species" (32% by weight, 36% by number, and between 18% and 38% per area by weight).

Acknowledgements

This work is part of the research project "*Assessment of the impact of boat seine fishery in the fisheries resources"*, financed by the Greek Ministry of Rural Development and Food. The authors thanks to the masters and the crew of the fishing vessels around Greece who participated in the project.

References

1 - Anon., 2009. Assessment of the impact of boat seine fishery in the fisheries resources. Ed. G. Petrakis, Final Report, HCMR, 2009.

2 - Petrakis, G., Chilari, A. and Kavadas, S. 2004. Retained and discarded catches from commercial boat seines in Greek waters. *Rapp. Comm. Int. Mer Medit.*, Vol. 37: 419.

3 - Petrakis, G., MacLennan, D.N. and Newton, A.W., 2001. Day-night and depth effects on catch rates during trawl surveys in the North Sea. *ICES J. Mar. Sci.*, 58: 50-60.

A SCALE OF DAMAGED FISH (SDF)

George Petrakis [1]*, Anna Cheilari [2] and Giulia Cambiè [3]

[1] Hellenic Centre for Marine Research, Institute of Marine Biological Resources, Aghios Kosmas, Hellinikon 16610 Athens, Greece - gpetr@ath.hcmr.gr

[2] European Commission, Joint Research Centre JRC.G.4. Maritime Affairs Unit, Via E. Fermi 2749 (TP 051), 21027 Ispra, Italy

[3] Department of Animal Biology, Vegetal Biology and Ecology, University of A Coruña, Campus da Zapateira s/n, E-15071 A Coruña, Spain

Abstract

One of the main issues related to net fisheries is that potentially commercial fish are discarded because they are partly or totally destroyed by scavengers while they remain on the nets in the sea. During trammel net selectivity experiments in Greece in summer 2004, observations on the condition of the fish after retrieval of the nets have been made. A qualitative "scale of damaged fish" (SDF) was created in order to record the condition of the fish according to 5 gradients: from 1: fully destroyed to 5: without any damage. The results related to hake and common pandora are presented.

Keywords: Ionian Sea, Fisheries

Introduction

The Greek fishing fleet is characterized by an enormous number of small-scale coastal vessels, with high diversification of gears and techniques. Trammel nets are one of the most commonly fishing gears used by small scale fisheries along the Greek coasts. However, there are only sporadic attempts to study these fisheries [1], [2], [3]. In several métiers, the extended deployment (in time) of the nets in the water, the way of the fish capture and other characteristics of each haul (such as the depth), can lead to death of the fish in the nets. The fish caught, attract scavengers that feed on them and thus destroy the catch, causing subsequent discarding and uncounted mortality. The aim of this work is to study the discarding practice of trammel nets and introduce a scale of damaged fish.

Material and Methods

Experimental fishing trials with trammel nets of four different mesh size combinations took place in the Ionian Sea (Greece) along the west coasts of Peloponnissos, during June and July 2004. The mesh sizes used for the inner net were: 44, 56, 72 and 80 mm. All nets were made up of sheets of the four mesh sizes joined end to end to make up a fleet and arranged in random order. For each mesh size, a net of 500 m was used. A total of 76 sets of nets were deployed at depths ranging from 10 to 130 m. Normal fishing practices were followed. The nets were set during sunrise and retrieved in the following morning. The soaking time presented a mean value of 21 h (ranged from 12 to 24 h) while for two hauls the soaking time was 46 h. The number of specimens and the total weight per species were recorded and for each fish the total length was measured to the nearest mm.

One of the main problems of net fishery is that an important part of the catch (fish of commercial size) is destroyed by polychaetes or other marine organisms while the net remains into the sea. For the evaluation of the physical damages, the following "scale of damaged fish" (Table 1), was created in order to record the causes and the severity of the damages incurred, in relation to commerciality.

Tab. 1. Description of the Scale of Damaged Fish (SDF)

Scale	Description of damages	Commerciality
5	No damages	Always
4	Few damages, usually eyes and gills are eaten. Some small damages in the flesh caused by bites from cephalopods or other fish	Usually
3	Medium extended damages, eyes, gills and part of the abdominal area eaten. Same damages in the flesh due to bites from cephalopods or other fish	No, private consumption or discarded
2	Extended damages, eyes, gills and part or the whole of the abdominal area eaten. Severe damages in the flesh caused by bites from cephalopods or other fish	No
1	Fully destroyed, only skin and skeleton remain. In many cases, species identification is difficult	No

;

Results and Discussion

A total of 2.782 individuals were caught belonging to 76 species and weighting 315 Kg. Discarded fish composed 29% by number and 24% by weight of the catch. Discards were species with no commercial value, or commercial species, either because they were small sized or because their physical appearance (damages by other fish, polychaetes, cephalopods or on the winch during hauling) was appalling and they had no commercial value.

According to the scale presented above for the description of fish condition, 4.6, 5.9, 8.6, 8.1 and 72.7% of all the fish caught were classified in the gradients: 1, 2, 3, 4 and 5, respectively. The organisms that cause the damages differ and act in many ways; i.e polychaetes destroy first the eyes and the gills, then enter through the branchial opening and destroy the abdominal region, whereas the cephalopods remove the outer parts of the flesh.

Although detailed data per species are not presented here, significant quantities of commercial species are discarding due to damages caused by other species: 45% of common dentex, 40% of common pandora, 36% of common two-banded seabream, 30% of brown meagre, 20% of hake, 29% of common seabream, (upublished data). The differences that were observed between the species could be attributed to the resistance of the fish on the net, the time of capture, the visibility of the fish inside the water, etc.

The reason of discarding of the commercial species is almost always not the size but the condition of fish. Given that damages begin after the fish has died on the net, the soaking time is an important factor. A logistic regression analysis with the soaking time as single predictor reveals that this factor is significant in determining the discard probability (p-value=0.01, estimate=0.04, SE=0.01). The discarded common pandora and hake (Fig. 1) were well above the minimum landing size (MLS) and thus potentially marketable.

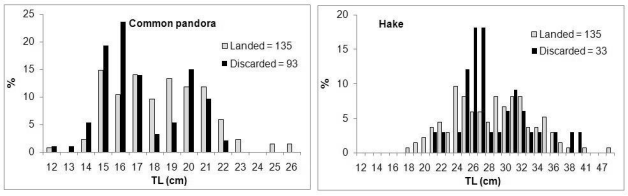


Fig. 1. A) Common pandora and B) hake landings and discards length composition from trammel nets, in Ionian Sea, June-July 2004

By cutting down the time of operation, the number of discards is expected to reduce. In Portugal, the length of time trammel nets and gill nets are permitted to remain in the water is limited in order to reduce spoilage and subsequent discarding of commercial species [4].

Acknowledgements : This work is part of the research project "*Development of an integrated management system to support the sustainability of Greek fisheries resources, IMAS-FISH"*, financed by the GreekMinistry of Development. The authors are grateful for the help of the master and the crew of the fishing vessels "Kapetan Michalis" and "Aghios Nikolaos".

References

1 - Anon., 1998. Selectivity of fixed nets in Mediterranean (SELMED). Ed. J.Sacchi, EEC contract: 95/C/76/12.

2 - Petrakis G. and Politou C.-Y., 2001. Cuttlefish trammel net 'metier' in Greece. Rapp. Comm. int. Mer Medit. 36: 309p.

3 - Petrakis G., 1999. CPUE and Catch composition in five small scale fisheries metiers in Greek waters. Mazara del Vallo, 7-8 May 1999. Stock assessment of coastal species caught by artisanal fishery.

4 - Borges T.C., Erzini K., Bentes L., Costa M.E., Gonçalves J.M.S., Lino P.G., Pais C. and Ribeiro J., 2001. By-catch and discarding practices in five Algarve (southern Portugal) métiers. *J. Appl. Ichthyol*., 17: 104-114.

ASPECTS OF THE REPRODUCTIVE BIOLOGY OF THE SQUAT LOBSTER *MUNIDA RUTLLANTI* ZARIQUIEY ALVAREZ, 1952 (DECAPODA: GALATHEIDAE) IN THE ADRIATIC SEA

Mirela Petric [1]*, Josipa Ferri [1] and Ivona Mladineo [2]
[1] University of Split, Center of Marine Studies - mirela.petric@unist.hr
[2] Institute of Oceanography and Fisheries

Abstract
Reproductive biology of *Munida rutllanti* was investigated for the first time in the Adriatic Sea. Carapace length of males ranged from 10.5 to 21.5 mm, while in females it ranged from 11.2 to 19.4 mm. Sexual dimorphism was observed in seven morphometric characters. Ovigerous females were first observed in summer and later in autumn with higher frequency. Realized fecundity showed wide variation (273-3250 eggs) and positive correlation between the brood and female size.
Keywords: Decapoda, Reproduction, Adriatic Sea

Introduction
Munida rutllanti Zariquiey Alvarez, 1952 is an Atlanto-Mediterranean species occurring from the nortwestern coast of Spain to Morocco and in the entire Mediterranean basin where is mostly found on muddy and shell-sand grounds of the continental shelf and upper slope. It constitutes well-established populations in the western Mediterranean and recently it has been more frequently reported from its eastern part. Due to its progressive spread, it is not surprising that this species has been reported in the Adriatic only after 2000 [1]. Despite the fact that *M. rutllanti* has been studied in other Mediterranean areas [2,3], we describe for the first time some biological parameters of this species from the eastern Adriatic.

Materials and Methods
The investigation was carried out in the eastern part of the central Adriatic Sea from May 2008 to April 2009 and total of 701 *Munida rutllanti* specimens were obtained. Samples were collected at depths from 110 to 200 m with commercial bottom trawl. Ovigerous condition of females was determined by presence or absence of eggs on pleopods. Ovigerous females were classified as 'non-eyed' (embryo without ocular pigment) and 'eyed' (embryo with ocular pigment) according to the stage of embryonic development. Fecundity was regarded as realized reproduction, which represents the number of eggs per clutch and was expressed by the regression equation of log-transformed number of eggs on carapace length at 'non-eyed' eggs of ovigerous females. To determine egg diameter, a subsample of 28 ovigerous females carrying eggs at the same stage of embryonic development was selected. Since the change in the allometry of cheliped growth represents the acquisition of secondary sexual characters, the same was used to determine size at morphometric maturity of males.

Results and Discussion
Carapace length (CL) of *Munida rutllanti* males ranged from 10.5 to 21.5 mm, while in females it ranged from 11.2 to 19.4 mm (Fig.1). Mean values of total length (TL), total carapace length (TCL), anterior carapace width (ACW), abdomen width (AW), cheliped length (ChL), propod length of cheliped (LCh) and propod width of cheliped (ACh) of males were statistically larger than of females (*t*-test: $t_{0.05}$ = 12.23, p = 0.0005; $t_{0.05}$ = 6.01, p = 0.0005; $t_{0.05}$ = 5.10, p = 0.0005; $t_{0.05}$ = 2.65, p = 0.008; $t_{0.05}$ = 13.38, p = 0.0005; $t_{0.05}$ = 13.28, p = 0.0005; $t_{0.05}$ = 14.39, p = 0.0005, respectively). This evident sexual dimorphism was previously reported for this species and other members of *Munida* genus [4]. Throughout the whole year, ovigerous females were first observed during summer months and were represented by 27.45% among the females, of which 76.19% were carrying 'non-eyed' embryos. In autumn, 48.95% of total females were ovigerous and most of them also brood 'non-eyed' embryos. The smallest ovigerous female measured 11.3 mm carapace length which suggest 11 mm CL as the size at physiological maturity of females. Present results indicate a wide variation in realized fecundity from 273 to 3250 eggs (average 1182 eggs) with egg number increasing with female CL. The regression analysis of carapace length versus number of eggs is given with equation: log F = 0.718 + 0.1478 log CL, (R^2 = 0.507). The average fecundity value and observed egg diameter (0.28 - 0.46 mm) in this study are somewhat lower when compare to other *Munida* species [4,5]. Cheliped growth was negatively allometric for immature males and positively allometric for mature males with an inflexion point at a CL value of 13.9 mm which represents the morphological size at maturity. In this study, with 74.41% of males being morphologically mature, we assumed that they will ensure the next offspring production. Finally, there is an indication of an annual and seasonal reproductive cycle with distinct summer/autumn breeding period for *M. rutllanti* in the Adriatic Sea, however, only a further study based on monthly samples throughout at least a two-year period will provide a better understanding of seasonality of the reproductive cycle.

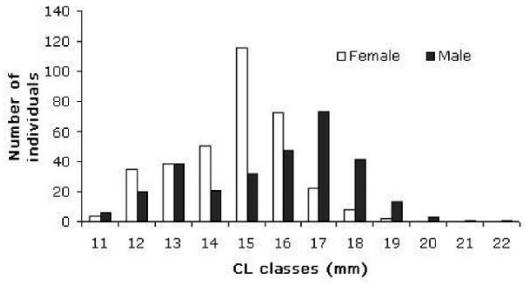


Fig. 1. The carapace length class of *Munida rutllanti* specimens from the eastern Adriatic

References
1 - Ungaro N., Marano C.A., Ceriola L. and Martino N., 2005. Distribution of demersal crustaceans in the southern Adriatic Sea. *Acta Adriat.*, 46: 27-40.
2 - Sanz-Brau A., Mezquita F. and Sanz S., 1998. Seasonality in the reproductive biology of a shelf-dwelling galatheid (Crustacea: Decapoda): an example from a Western Mediterranean population of *Munida iris rutllanti*. *Cah. Biol. Mar.* 39: 185-195.
3 - Kocak C., Leblebici S., Ozaydin O. and Katagan T., 2008. Some morphometric aspects of *Munida rutllanti* Zariquiey Alvarez, 1952 (Decapoda, Anomura, Galatheidae) in Sigacik Bay (Southeastern Aegean Sea). *Crustaceana*, 81: 873-881.
4 - Huguet C., Maynou F. and Abelló P., 2005. Small-scale distribution characteristics of *Munida* spp. populations (Decapoda: Anomura) off the Catalan coasts (western Mediterranean). *J. Sea Res.*, 53: 283-296.
5 - Tapella F., Lovrich G.A., Romero M.C. and Thatje S., 2002. Reproductive biology of the crab *Munida subrugosa* (Decapoda: Anomura: Galatheidae) in the Beagle Channel, Argentina. *J. Mar. Biol. Assoc. U.K.*, 82: 589-595.

A COMPARISON BETWEEN THE MACROSCOPIC AND MICROSCOPIC STAGING OF OVARIES IN *ARISTAEOMORPHA FOLIACEA* (RISSO, 1826)

L. Pirrera [1], A. Perdichizzi [1], F. Conti [2], V. Micale [1] and P. Rinelli [1]*
[1] Institute of Marine Coastal Environment (IAMC) - CNR of Messina - paola.rinelli@iamc.cnr.it
[2] Department of Animal Biology and Marine Ecology, University of Messina

Abstract
Specimens of *Aristaeomorpha foliacea* caught in the Southern Tyrrhenian Sea were examined in order to validate the macroscopic scale used in MEDITS project to determine the ovarian maturity of this commercial shrimp. The scale was tested against a microscopic examination of ovarian samples.
Keywords: Crustacea, Decapoda, Reproduction, Tyrrhenian Se

INTRODUCTION The red shrimp *Aristaeomorpha foliacea* (Risso, 1826) is an economically important resource of the Mediterranean Sea, mainly found between 300 and 700 m depth. Studies on reproductive biology of this shrimp are usually based upon macroscopic observation of gonads [1,2,3]. The present work attempts to validate the macroscopic scale for maturity staging of *A. foliacea* currently used in MEDITS project [4] by histological examination of ovarian tissue.

MATERIAL AND METHODS Shrimps were caught by commercial trawlers in the Southern Tyrrhenian Sea, at a depth of 600 metres, between January and July 2009. Ovaries (n = 50) from formalin fixed specimens were dissected in the laboratory, and macroscopically staged for maturity, according to MEDITS scale, as follows: 1, immature; 2a, virgin developing; 2b, recovering; 2c, maturing; 2d, mature; 2e, resting adult. Ovarian samples were processed for histology and observed under the light microscope.

RESULTS AND DISCUSSION Histological analysis allowed to distinguish 5 types of cells: oogonia, OO (<10±0.11 μm), early primary oocytes, EPO (15–25 μm), late primary oocytes, LPO (25–85 μm), early vitellogenic oocytes, EVO (90–300 μm), and late vitellogenic oocytes, LVO (>300 μm). Stage 1 ovaries contained mainly oogonia and early primary oocytes, together with some late primary oocytes. Both 2a and 2b ovaries (Fig.1) contained oogonia and early primary oocytes in a germinative zone, as well as late primary oocytes, arranged in tubules, in a maturative zone. Stage 2c ovaries (Fig. 2A) contained both early and late vitellogenic oocytes, besides EPO and LPO. Stage 2d ovaries were microscopically similar to 2c, except for one specimen, in which oocytes were found at a very advanced vitellogenic stage, with no nuclei, and a typical convoluted perivitelline space along the cell membrane (Fig. 2B), resembling the "cortical rods" described by Nazari *et al*. (2007) [5] in *Farfantepenaeus paulensis*, suggesting imminent spawning. No stage 2e individuals were found during the sampling period. Histological analysis confirmed the immaturity of stage 1 ovaries, and revealed no difference in the most advanced oocyte stage between 2a and 2b ovaries, which represent the same functional stage at different ages. Maturing (2c) and mature (2d) ovaries, which are clearly distinguishable macroscopically by colour, appeared histologically very similar, suggesting a fast achievement of yolk deposition in this species.

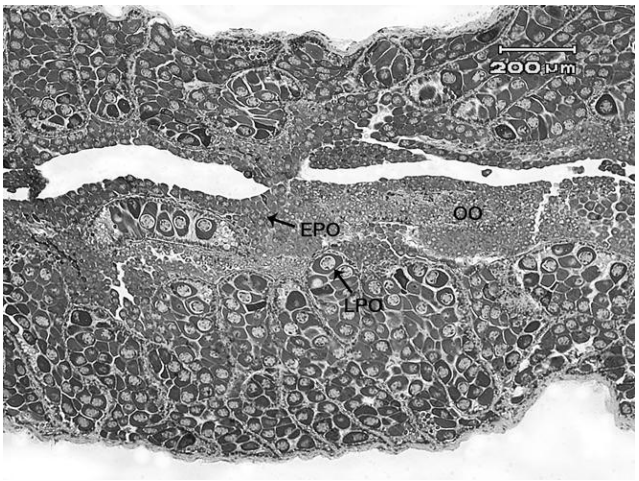


Fig. 1. Stage 2b ovaries of A. foliacea, with a germinative zone containing oogonia (OO) and early primary oocytes (EPO), and a maturative zone containing late primary oocytes (LPO)

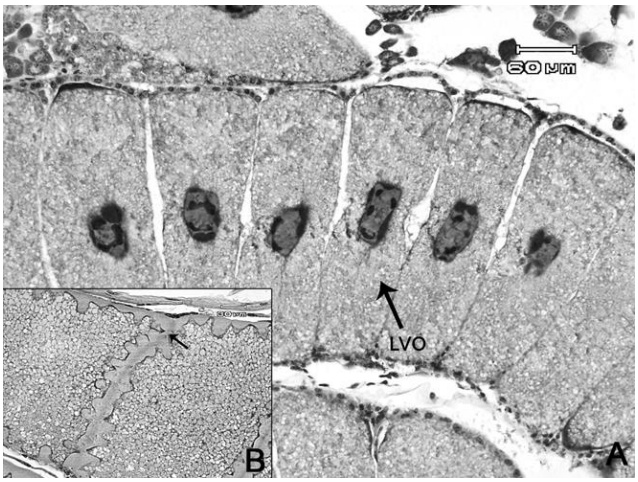


Fig. 2. Stage 2c ovaries of A. foliacea with late vitellogenic oocytes (LVO) pilled up as coins in a single row (A); stage 2d ovary with advanced late vitellogenic oocytes characterized by a convoluted perivitelline space along the cell membrane (B)

References
1 - Levi D. and Vacchi M., 1998. Macroscopic scale for simple and rapid determination of sexual maturity in *Aristaeomorpha foliacea* (Risso, 1827) (Decapoda, Penaeidae). *Journal of crustacean biology*, 8: 532-538.
2 - Politou C.Y., Kapiris K., Maiorano P., Capezzuto F. and Dokos J., 2004. Deep-sea Mediterranean biology: the case of *Aristaeomorpha foliacea* (Risso, 1827) (Crustacea: Decapoda: Aristeidae). *Sci. Mar*., 68 (Suppl. 3): 129-139.
3 - Kapiris K. and Thessalou-Legaki M., 2006. Comparative fecundity and oocyte size of *Aristaeomorpha foliacea* and *Aristeus antennatus* in the Greek Ionian Sea (E. Mediterranean) (Decapoda: Aristeidae). *Acta Zoologica* (Stockholm), 87: 239–245.
4 - Instruction Manual, version 5. MEDITS Project., 2007.
5 - Nazari E.M., Dias Bainy A.C., Ammar D., and Rauh Mu¨ ller Y.M., 2007. Ovarian staging in eyestalk ablated females of *Farfantepenaeus paulensis*: a histologic, morphometric, and biochemical analysis. *Journal of crustacean biology*, 27 (2): 296–303.

BENTHIC VAGILE FAUNA ASSOCIATED TO COLONIZATION PROCESSES IN THE NORTHERN ADRIATIC CORALLIGENOUS HABITATS

Massimo Ponti [1], Federica Fava [1]*, Roberto Gori [1] and Marco Abbiati [1]
[1] University of Bologna - federica.fava8@unibo.it

Abstract
Benthic vagile fauna associated to colonization processes in the northern Adriatic coralligenous habitats was investigated by means of tiles field experiments carried out from August 2005 to August 2008 in three different rocky outcrops offshore of Chioggia characterised by different epibenthic assemblages. Although most of the single taxa didn't show a clear distribution pattern, as well as the species diversity indices, assemblage structures significantly differed among plots and between sites. The interaction between sessile and vagile fauna could play a relevant role in structuring the epibenthic assemblages.
Keywords: Adriatic Sea, Zoobenthos, Continental Shelf, Marine Parks

Introduction
Numerous coralligenous rocky outcrops occur in soft silty-sandy sediments of the Northern Adriatic Sea bottom between 10 and 40 metres in depth, ranging in size from only a few to several thousands square metres, and raising between 1 and 4 metres from surrounding bottoms ([1]; [2]). The largest and better known outcrops are widespread offshore of Chioggia and Venice, between 18 and 30 m in depth and from 6 to 24 km from the coast and their ecological importance were recognised by the institution of a No Take Zone in 2002 ([3]). According to previous studies, epibenthic assemblages on subtidal hard bottoms offshore of Chioggia show high heterogeneity at a range of spatial scales, form 10s to 1000s of meters ([4]). The assemblages occurring on these outcrops could be clustered in three main typologies consistent with time and characterised by different abundance of algal turf, encrusting calcareous algae, encrusting and boring sponges and colonial ascidians ([4]). In order to assess the role of the recruitment processes in determining such variability, colonization patterns have been investigated in a long-term field experiment based on travertine tiles ([5]). The aim of the present study is to analyse the vagile fauna associated to the colonized tiles three years after their deployment.

Material and methods
Three study sites offshore of Chioggia, representing the three main hard bottom benthic assemblages identified in the previous study, were randomly chosen. Site P204 (6.6 km far from the coast, depth 20 m, 45° 12.665' N 12° 23.038' E) was dominated by algal turf and encrusting sponges, MR08 (14.6 km far from the coast, depth 22 m, 45° 13.825' N 12° 29.365' E) was characterised by red calcareous algae and colonial ascidians, while P213 (15.0 km far from the coast, depth 25 m, 45° 10.264' N 12° 30.999' E) presented intermediate abundances of algal turf and encrusting algae. In August 2005, three plots were randomly selected in each site, and for each plot sixteen travertine tiles (15.0 x 11.5 x 1.0 cm) were horizontally deployed in contact with the natural hard bottom. Three years after the deployment, tiles appeared indistinguishable from the surrounding bottom. In August 2008, four tiles for each plot were collected with the associated vagile fauna and preserved by 4% formaldehyde in separate plastic bags. Species were identified to the lowest possible taxonomic level and their abundance was estimated as number of individuals per sample. Differences between plots and sites were assessed by uni- and multivariate permutational analysis of variance (PERMANOVA, [6]).

Results
Overall 98 taxa were identified. Tanaidacea, Copepoda, *Bittium reticulatum*, *Leptochelia savignyi* and *Sillys* sp. were the most abundant taxa. Although most of the single taxa didn't show a clear distribution pattern, as well as the species diversity indices, assemblage structures significantly differed among plots and between sites. Vagile assemblages were correlated with those sessile colonizing the tiles. In particular, the gastropod *Bittium reticulatum* and the caprellid amphipod *Phtisica marina*, generally associated with algal turf and hydroids were more abundant in the site P204 dominated by a large amount of algae, while the isopod *Jaeropsis* sp., commonly found in the Mediterranean coralligenous habitats ([7]), was more abundant in the site MR08, characterised by red calcareous algae. Vagile assemblages appeared also correlated with depth, distance from the cost and spatial extent of the outcrops.

Discussion
The formation and maintenance of benthic assemblages on subtidal rocky bottoms largely depends by settlement and recruitment processes determined by the interaction of biotic and abiotic factors which operate at different spatial and temporal scales ([8]). Also post-recruitment processes including post-larval dispersion and intra- and interspecific interaction could play a relevant role ([9]). The analysis of the recruitment sequence of sessile species highlighted the importance of both early colonisation processes and following competitive interaction between species in structuring the epibenthic assemblages in the northern Adriatic subtidal rocky bottoms ([5]). The interaction between sessile and vagile fauna could also play a relevant, thought often largely neglected, role in structuring the epibenthic assemblages ([10]).

References
1 - Gabriele M., Bellot A., Gallotti D., Brunetti R., 1999. Sublittoral hard substrate communities of the northern Adriatic Sea. *Cahiers de Biologie Marine* 40: 65-76.
2 - Casellato S., Stefanon A., 2008. Coralligenous habitat in the northern Adriatic Sea: an overview. *Marine Ecology-an Evolutionary Perspective* 29: 321-341.
3 - Fava F., Ponti M., Abbiati M., 2008. Possible effects of different protection levels on the epibenthic assemblages: the tegnùe of Chioggia. *Biologia Marina Mediterranea* 15: 158-159.
4 - Fava F., Ponti M., Abbiati M., 2009. Spatial-temporal variability of epibenthic assemblages on rocky outcrops in the northern Adriatic continental shelf. In: Science and management of estuaries and coasts: a tale of two hemispheres. Abstract of the ECSA 44th International conference. ECSA Buletin No 53. Bahía Blanca, Argentina.
5 - Ponti M., Fava F., Cannillo F., Colosio F., Abbiati M., 2007. Colonization patterns of epibenthic invertebrates on subtidal hard bottoms in the northern Adriatic Sea. In: *Ecologia, limnologia e oceanografia: Quale futuro per l'ambiente?, Riassunti del XVII Congresso Nazionale S.It.E. e del XVIII Congresso Nazionale A.I.O.L.* Ancona, 18-20 September 2007.
6 - Anderson M.J., ter Braak C.J.F., 2003. Permutation tests for multi-factorial analysis of variance. *Journal of Statistical Computation and Simulation* 73: 85-113.
7 - Ballesteros E., 2006. Mediterranean coralligenous assemblages: a synthesis of present knowledge. *Oceanography and Marine Biology*: an Annual Review 44: 123-195.
8 - Rodriguez S.R., Ojeda F.P., Inestrosa N.C., 1993. Settlement of benthic marine-invertebrates. *Marine Ecology-Progress Series* 97: 193-207.
9 - Connell J.H., 1985. The consequences of variation in initial settlement vs. post-settlement mortality in rocky intertidal communities. *Journal of Experimental Marine Biology and Ecology* 93: 11-45.
10 - Anderson M.J., Underwood A.J., 1997. Effect of gastropod grazers on recruitment and succession of an estuarine assemblage: a multivariate and univariate approach. *Oecologia* 109: 442-453.

OVARIES DEVELOPMENT OF PARAPENAEUS LONGIROSTRIS (CRUSTACEA: PENAEIDAE) IN THE SARDINIAN WATERS

Cristina Porcu [1], Alice Gastoni [1]*, Benedetta Podda [1] and Andrea Sabatini [1]
[1] Department of Animal Biology and Ecology – University of Cagliari - gastoni@unica.it

Abstract
In this paper, we report a description of female maturity stages of the deep-water rose shrimp *Parapenaeus longirostris* caught in the Sardinian waters between 250 and 440 m. Macroscopic and histological analysis were performed on 665 females. The observation on the ovaries leads to conclude that there are six stages of development.
Keywords: Decapoda, Reproduction, Western Mediterranean

Introduction
The deep-water rose shrimp *Parapenaeus longirostris* (Lucas, 1846) is one of the most important commercial shrimps in many Mediterranean and Atlantic fisheries [1,2,3,4]. The aim of this paper is to identify and classify the maturity stages of females based on macroscopic and microscopic features of the ovaries.

Materials and Methods
Observations on the reproduction were made through monthly samples collected by commercial trawlers on epi-bathyal bottoms off Sardinian waters (central western Mediterranean Sea) between 250 and 440 m of depth. A total of 665 females were examined. Parameters recorded included carapace length (CL, mm) and sex; moreover, on the basis of size, shape and colour of gonads, the female maturity stages were defined. The ovarian tissues, preserved in salin formol 5%, were processed. Transverse sections (3.5 μm) were stained with sodium iodoeosine and toluidine blue (Dominici's method) [5].

Results and Discussion
The specimens showed a range in size between 17.3 and 39.8 mm CL. Macroscopic and microscopic examination of the ovaries revealed six maturity stages:
Stage 1A (immature, virgin): typical of young immature specimens (17.3-18.1 mm CL). Thin and translucent ovaries with a tubular appearance and adherent to the dorsal portion of the digestive gland. A large number of oogonia, found grouped in the germinal zone, start to divide and can be observed at all stages of maturation. The primary oocytes (PO) with a large nucleus are visible.
Stage 2A (developing) / 2B (recovering): whitish or pale yellow ovaries, larger in volume than the previous stage ones. The paragastric lobes start to cover the sides, while the caudal extensions occupy all abdominal somites. These two stages differ only for the body size (2A: 20-24.1 mm CL; 2B: 25-38 mm CL). Microscopically, in the maturative zone, PO, surrounded by a monolayer of follicle cells, show a large nucleus with nucleoli flattened around the periphery.
Stage 2C (maturing): dark yellow-light green ovaries. Frontal lobes and caudal extensions are turgid and well defined (20.3-38 mm CL). From the histological analysis, besides all the previous cell types, primary (Y1) and secondary (Y2) vitellogenic oocytes were also visible. The first ones had a polyhedral shape with a nucleus containing several round nucleoli and the cytoplasm field with yolk granules and lipidic vesicles;
Stage 2D (mature): turgid ovary of different shades of dark green, completely developed occupy the entire thoracic cavity. The eggs are well visible (20.3-39.8 mm CL). All previous microscopic cells type are present. The nucleus of Y2 oocytes migrate to the peripheral zone and the ready-to-spawn oocytes show a characteristic margin of peripheral "rod-like bodies" [6].
Stage 2E (spent): green-brown ovaries that lose the characteristic turgidity of the previous stage and become flaccid (25.9-37.1 mm CL). Empty ovarian tissue and characterized by oocytes in reabsorbtion. The fully mature oocytes were still visible. The maturation process of *P. longirostris* ovaries exhibited progressive changes in color and volume from immature stages to mature ones. The gonad extends through the abdominal cavity since the first stage of the development.

References
1 - D'Onghia G., Matarrese A., Maiorano P. and Perri F., 1998. Valutazione di *Parapeneus longirostris* (Lucas, 1846) (Crustacea, Decapoda) nel Mar Ionio. *Biol. Mar. Medit.*, 5 (2): 273-283.
2 - Levi D., Andreoli M.G. and Giusto R.M., 1995. First assessment of the rose shrimp, *Parapenaeus longirostris* (Lucas, 1846) in the centralMediterranean. *Fish. Res.*, 21: 375-393.
3 - Sbrana M., Viva C. and Belcari P., 2006. Fishery of the deep-water rose shrimp *Parapenaeus longirostris* (Lucas, 1846) (Crustacea: Decapoda) in the northern Tyrrhenian Sea (western Mediterranean). *Hydrobiologia*, 557: 135–144.
4 - Sobrino I. and García T., 1994. Biology and fishery of the deepwater rose shrimp, *Parapeneus longirostris* (Lucas, 1846), from the Atlantic Moroccan coast. *Sci. Mar.*, 58 (4): 299-305.
5 - Mazzi V., 1977. Tecniche istologiche e istochimiche, eds. Piccin, pp 750.
6 - Tom M., Gorem M. and Ovadia M., 1987. Localization of the vitellin and its possible precursors in various organs of *Parapenaeus longirostris* (Crustacea, Decapoda, Penaeidae). *Int. J. Invertebr. Reprod. Devel.*, 12: 1-12.

SHARK RECORDS IN THE STRAITS OF MESSINA (CENTRALMEDITERRANEANSEA): *HEXANCHUS GRISEUS* (BONNATERRE, 1788)

Andrea Potoschi [1], Gianmichele Iaria [2] and Nunziacarla Spanò [1]*
[1] Università degli Studi di Messina, Dip.to Biologia Animale ed Ecologia Marina - spano@unime.it
[2] Oloturia Sub

Abstract
The problem of the biogeographical distribution of organisms is still connected to the distinction in the districts of the Mediterranean Sea. In this context, the Straits of Messina, as it has ecological features of significant interest that pose the questions and suggest biogeographical implications. The intense hydrodynamism, the low temperatures and the abundance of salts, transported to the surface from the deep water, make available a large amount of organic matter consumed by coastal populations. In this context, should be included repeated sightings of *Hexanchus griseus*, an abyssal species, which in the Strait is found at depths from 5 and 40 m, in special conditions of moon phase and current.
Keywords: Strait Of Messina, Biogeography

The biogeography distribution of marine organisms is linked to the subdivision into different districts of the Mediterranean basin. Nevertheless, the active interactions existing among several communities and their habitats reject such classical model of distribution. The Strait of Messina represents the junction of two basins, the Ionian and the Tyrrhenian Sea. Here, strong sea currents drive a complex displacement of water [1, 2]. Waters move between the two basins over a sill 70-110 meters deep, with a NW-SE oriented mouth. The sill morphology has a fundamental role not only for the hydrological regime of the Straits but also for the distribution of benthic populations occurring in this environment [3, 4]. Such hydrodynamism is responsible for the high biodiversity of the area. Intense strong currents and upwelling phenomena release a large quantity of organic matter that is used by coastal benthic populations. The peculiar morphologic, oceanographic and biological asset of the area determines an Atlantic-like ecosystem [5, 6]. In this particular environment has been repeatedly detected the species *Hexanchus griseus* (Fig. 1).



Fig. 1. *Hexanchus griseus* in the Giardini Naxos harbour

This species is a benthonic deep water shark that commonly lives between 700 - 2000 meters; is one of the biggest sharks of the Mediterranean Sea that can reach 5 meters in length and 800 kg of weight [7]. In the Straits of Messina, *H. griseus*, during particular moon and tide phases, comes to shallow waters up to 15-30 meters of depth. During these periods, six-gill sharks have been commonly sought by scuba divers. From 1993 we had begun a visual scuba dive program of this species and were found numerous specimens including an adult female of 4 meters (Iaria pers. comm.). In 2007 *Hexanchus griseus* was sampled in an upwelling area south of the Straits of Messina (Giardini Naxos), under the framework of EU project ("Ge.In.Fa.Co. - individuazione e messa a punto di un modello per lo sviluppo sostenibile e per la gestione integrata della fascia costiera nell'area di Giardini Naxos - POR SICILIA 2000-We hypothesize that there is a strong correlation between vertical migrations of *H. griseus* and presence of a large quantity of organic matter and benthic organisms. Probably the species follows northern upwelling currents as well as other many species characteristic of the area. In the near future we aim to undertake a collaborative project of underwater tagging and photo-identification to gain insight on six-gill shark migration and distribution in the Mediterranean Sea 2006).

References
1 - De Domenico E., 1987. Caratteristiche fisiche e chimiche delle acque nello Stretto di Messina. *Doc. et Trav*., IGAL, Paris, 11: 225-235.
2 - Mosetti F., 1995. Tidal and other currents in the Straits of Messina. In: The Straits of Messina Ecosystem. L. Guglielmo, A. Manganaro and E. De Domenico (eds), Italy, pp 13-30.
3 - Di Geronimo S.I. and Giacobbe S., 1987. Bionomie des peuplements benthiques des substrats meubles et rocheux plio-quaternaires du Détroit de Messina, *Doc. et Trav*., IGAL, Paris, 11: 153-169.
4 - Giacobbe S., Rinelli P. and Spanò N., 1996. Echinodermi e Crostacei decapodi in fondi mobili litorali del versante calabro dello Stretto di Messina. *Biol. Mar. Medit.*, 3 (1): 400-406.
5 - Fredj G. and Giaccone G., 1987. Bionomie des fonds a Laminaires du Détroit de Messina. *Doc. et Trav*., IGAL, Paris, 11: 237-238.
6 - Di Geronimo S.I. and Fredj G., 1987. Les fonds a Errina aspera et Pachylasma giganteum. *Doc. et Trav*., IGAL, Paris, 11: 243-247.
7 - Compagno L.J.V., 1984. FAO Species catalogue: sharks of the world. FAO fisheries synopsis, vol. 4, part 1.

SYMBIODINIUM SP. CAN STAY ALIVE THROUGH THE GUT AND IN THE FAECES OF CNIDARIA PREDATORS. THE CASE OF *CORALLIOPHILLA MEYENDORFFI* AND *ANEMONIA VIRIDIS*.

Mathieu Poulicek [1]*, Stéphane Roberty [1], Sylvain Plaza [2] and Ophélie Ladriere [1]
[1] Liège University, Marine Ecology unit, Chemistry Institute B6C - mpoulicek@ulg.ac.be
[2] STARESO, BP33, F-20290 Calvi (Corsica, France)

Abstract
The gastropod *Coralliophilla meyendorffi* is a common predator of the zooxanthellate anemone *Anemonia viridis*. Zooxanthella from the anemones are an important constitutent of the mollusc faeces. Cell integrity, occurence of flagellated forms, live/dead proportions and mitotic index of *Symbiodinium* collected from the faeces and cultivated in vitro were examined and compared to that of algae *in hospite*. The results show that most algae withstand digestive processes of the predator, staying alive and dividing actively in the faeces. Motile (lagellated) algae arise from dividing cells and escape the fecal pellets.
Impact on coral bleaching recovery is discussed.
Keywords: Cnidaria, Dinoflagellates, Symbiosis, Predation, Fecal Pellets

Introduction
Many eukaryotic microalgae live in symbiosis with marine invertebrates. One of the most widely distributed and abundant intracellular algae are the zooxanthellae (dinoflagellates of the genus *Symbiodinium*) in symbiosis within cells of reef forming corals and of other cnidaria [1]. The increased frequency of disruption of this symbiosis (coral bleaching) is a major threat for coral reefs future [2]. In order to recover, bleached cnidaria can, either let proliferate the algae not previously expelled (5 to 25 % of the initial stock) or catch free *Symbiodinium* in the environment [3,5,7]. Both processes potentially result in algae community changes, favouring environmentally better adapted strains (adaptive theory of bleaching [8,9]). As "free" zooxanthellae are quite rare in the plankton [1], one can look for other possible sources of symbionts. Here we investigate the potential role of undigested algae embedded in the faeces of cnidaria predators as source of zooxanthellae for recolonization of bleached hosts.

Material and methods
In June 2009, 15 live *Anemonia viridis* (Forskal, 1775) and 15 *Coralliophilla meyendorffi* (Calcara, 1845) were collected by scuba diving (3-8 m depth) close to the oceanographic station STARESO (Calvi, Corsica) and kept separate for acclimatization during one month in free flowing aquaria in the laboratory under in situ light and temperature conditions (18 to 22°C, maximum light intensity 1970 lumen m^{-2}). Experiments were performed in July 2009. Anemone extracted zooxanthellae were collected by gentle homogenization of 0.5 g (FW) of anemone tentacles in 10 ml of 0.2 µm filtered SW with a potter grinder, then purified from anemone debris by filtration (50 µm pore size) and centrifugation (500 x g), resuspended and cultured under in situ illumination and temperature in F/2 medium. Faeces zooxanthellae were recovered by grinding freshly collected faeces of *Coralliophilla* exclusively fed with *Anemonia* for 1 week, then purified and cultivated the same way. Algae density in culture was monitored in both cases for 12 days (5 replicates) by epifluorescence counts. Mitotic indexes (MI, as % of "doublets", N >500 cells) and % dead cells (Trypan blue permeation test, N>300 cells) were recorded every day at 9h00 in culture samples. Apparition of motile (flagellated) cells was monitored along nycthemeral cycles (during the log phase of both cultures) during 48 hours every 2 hours.

Results and discussion
Most zooxanthellae found in the faeces are alive (> 80 %) and able to multiply quickly. Actively growing cultures were obtained from algae either directly extracted from anemones or from faeces of *Coralliophilla* exclusively fed with *Anemonia viridis*. There are no significant differences between the kinetics of both growth curves : lag phase last approximately 6 days and logarithmic growth for another 6 days, culminating with densities around 200 to 250 10^3 algae ml^{-1} (inoculum was 25 10^3 cell ml^{-1}).
The MI of faeces isolated algae is significantly lower than the MI of anemone extracted ones during the 3 first days of culture (0.8 to 1.2% compared to 2.0 to 2.8%) ; there is no significant difference during the following days. MI is classically low in zooxanthellae, close to 2 to 5 % of the population according to strains, light and nutrients supply [4,6]. Maximum MI occurs after 8 days of culure (2.9 to 3.4%). Division occur mainly during the very first hours of "light" period (from 6h30 to 9h00 in our conditions, 100 to 600 lumen m^{-2}) and at dusk (18h30 to 21h00, 400 to 100 lumen m^{-2}).
Division peaks were followed by apparition of motile algae (8h30 to 10h30 and from 20h30 to 21h30). There were virtually no flagellated forms during the night (light intensity < 50 lumen m^{-2}), and very few ones (< 0.2 % during the most illuminated hours of the day, > 600 lumen m^{-2}). This conforms to previous observations under natural conditions [6]. Motile cells also escaped from undisturbed fecal pellets even if most cannot get free from mucous threads in which algae are embedded.
% dead cells was much higher just after isolation from *Coralliophilla* faeces (10 to 25% of the population at day 1) compared to anemone extracted ones (2 to 7%). From day 3 to day 12, the % dead cells in culture remained constant around 2% of the algae population for both conditions.

Conclusion
Most symbiotic zooxanthellae from *Anemonia viridis* consumed together with animal tissues by the gastropod *Coralliophilla* withstand digestion and are recovered alive, actively dividing and potentially motile in the faeces of the predator. Observations by Fit & Trench [5] on *Cassiopeia* scyphistome show that live *Symbiodinium* cells introduced in the coelenteron resist digestion by the cnidaria and are internalized (endocytosis) by endodermal cells. So, fecal pellets, once resuspended in the POM could be a source of algae for recolonization of bleached host. Moreover, flagellated cells produced by undigested zooxanthellae in faeces are another potential source as these motile algae are attracted to potential hosts [4], if freed from mucous threads. It should be quite interesting to check the hypothesis that faeces and fecal pellets of cnidaria predators may constitute a reservoir of live zooxanthellae able to be consumed and internalized during recovering phases post-bleaching.

References
1 - Coffroth M.A., Lewis C.F., Santos S.R & Weaver J.L., 2006. Environmental populations of symbiotic dinoflagellates in the genus *Symbiodinium* can initiate symbioses with reef cnidarians.*Curr.Biol.*,16:985-987.
2 - Hoegh-Guldberg O., 1999. Climate change, coral bleaching and the future of the world's coral reefs. *Mar.Freshw.Res.*,50:839-866.
3 - Lewis C.L. & Coffroth M.A., 2004. The acquisition of exogenous algal symbionts by an octocoral after bleaching. *Science*,304:1490-1492.
4 - Pasternak Z., Blasius B., Abelson A. & Achituv Y., 2006. Host-finding behaviour and navigation capabilities of symbiotic zooxanthellae. *Coral Reefs*,25(2):201-207.
5 - Fitt W.K. & Trench R.K., 1983. Endocytosis of the symbiotic dinoflagellate *Symbiodinium microadriaticum* Freudenthal by endodermal cells of the scyphistomae of *Cassiopeia xamachana* and resistance of the algae to host digestion.*J.Cell Sci.*,64:195-212.
6 - Wilkerson F.P., Muller-Parker G. & Muscatine L., 1983. Temporal patterns of cell division in natural populations of endosymbiontic algae.*Limnol.Oceanogr.*,28:1009-1014.
7 - Berner T., Baghdasarian G. & Muscatine L., 1993. Repopulation of a sea anemone with symbiotic dinoflagellates: analysis by in vivo fluorescence.*J.exp.mar.Biol.Ecol.*, 170:145-158.
8 - Baker A.C.,2004. Symbiont diversity on coral reefs and its relationship to bleaching resistance and resilience. *In* Rosenberg E. & Loya Y eds, Coral Health and Disease, Springer, pp.177-194.
9 - Buddenmeier R.W., Baker A.C., Fautin D.G. & Jacobs R., 2004. The adaptive hypothesis of bleaching. *In* Rosenberg E. & Loya Y. eds, Coral Health and Disease, Springer, pp. 427-444.

THE CONTRIBUTE OF THE MANILA CLAM TO THE SECONDARY PRODUCTION OF THE BENTHIC COMPARTMENT IN THE VENICE LAGOON

F. Pranovi [1]*, P. Franzoi [1], M. Pellizzato [2], M. Zucchetta [1] and P. Torricelli [1]
[1] Environmental Sciences Dept., University Cà Foscari Venice, Italy - fpranovi@unive.it
[2] AGRI.TE.CO sc Ambiente Progetto Territorio

Abstract
A first attempt to quantify the contribute of the Manila clam (*Ruditapes philippinarum*) to the secondary production of the benthic compartment of the lagoon of Venice is described. The potential exploitable production, based on available data about the clams distribution and annual catches, has been estimated on a spatial basis within the main fishing grounds and compared with experimental data about the secondary production of the macrobenthic community of the lagoon, recorded in areas not interested by the clam harvesting activity.
Keywords: Bivalves, Alien species, Secondary Production, Lagoons, Adriatic Sea

Introduction
As previously described by other authors [1], the introduction of the Manila clam - *Ruditapes philippinarum* (Adams & Reeve,1850) - in the lagoon of Venice and the subsequent demographic explosion directly affected the ecosystem functioning. Among the other effects, an increase of the benthic compartment production has been recorded, as reflected by the 40000 tons of catches per year reported at the end of the last century. Therefore, the voluntary introduction of the Manila clam represented the most successful event for the Italian shellfish aquaculture and, at present, Italy results to be the main clam producer in Europe. For this reason, this species can represent a good model to analyse ecological effects related to an alien species introduced for commercial purposes in a marine ecosystem. The aim of the paper is to use the secondary production as a proxy to assess the effects on ecosystem functioning due to the non-native species, *Ruditapes philippinarum*. By using available data from different sources, the clam potential exploitable production, for each one of the main fishing grounds, has been estimated on a spatial basis and compared with secondary production estimates for the macrobenthic community, experimentally obtained for different areas of the lagoon.

Material and methods
In the context of the present situation, characterized by local administrations efforts to enforce the management policy, allocating resources and fishermen in small portion of the lagoon, a lack of reliable and well structured databases about Manila clam have been recorded. To estimate the potential exploitable production on a spatial basis, the most recent biomass density data collected within the main fishing grounds [2, 3, 4,] were used as proxy for production distribution. Biomass values (wet weight, $g \cdot m^{-2}$) for each area were interpolated by using ordinary kriging on a 10 m square cells grid, after fitting the best model on the experimental variogram, using the 'gstat' library [5] of R software packages. For each area, a relative biomass index was then computed by dividing biomass of each cell by the total biomass of the area. The production distribution in each area was obtained by multiplying the annual production for the area by the relative biomass index. Estimated production values, transformed in ash free dry weight, were finally interpolated on a 100 m square cells grid. This interpolation was used to estimate the contribute of the Manila clam to the production of the benthic compartment by using, as reference, the mean value of 27.5 g AFDW m^{-2} y^{-1}, recorded in areas outside clam fishing grounds and outside seagrass meadows [6].

Results and discussion
Obtained results highlight a significant contribution (from 1 to 4-5 times the value recorded outside the fishing grounds) of the Manila clam to the benthic compartment secondary production (Fig. 1). This could find explanation in terms of an optimization of the resources exploitation, as suggested by the bentho-pelagic coupling increase. The Manila clam is, indeed, characterized by a general 'rusticity'. Moreover, in the fishing grounds the population is maintained in the 'young phase' (with high r values) by the fishing activity itself. Finally, the presence of positive feedbacks with the fishing activity, due to the re-suspension of organic matter from the sea-bottom, has been described [7]. Estimates here presented, allowed for a first quantification of positive effects of the Manila clam on goods and services of the Venice lagoon, which in some way, represent the other side of the medal when assessing the global effect of non-native species on the ecosystem
functioning.

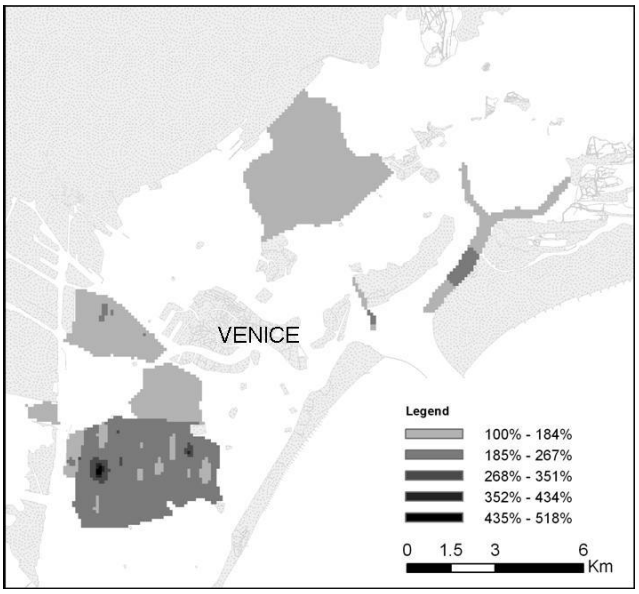


Fig. 1. Contribution of the Manila clam to Secondary Production of the benthic compartment. Data are expressed as percentage referred to the mean production experimentally recorded outside the clam fishing grounds

References
1 - Pranovi F., Franceschini G., Casale, M., Zucchetta M., Giovanardi O. and Torricelli P., 2006. An ecological imbalance induced by a non-native species: the Manila clam in the Venice Lagoon. *Biol. Inv.*, 8: 595-609.
2 - Provincia di Venezia - Agriteco., 2006. Valutazione dei quantitativi e della distribuzione della vongola *Tapes philippinarum* di taglia commerciale nella macroarea del bacino centrale della laguna di Venezia. Relazione del 17/03/2006.
3 - G.R.A.L. - Provincia di Venezia - Agriteco., 2007. Verifica quantitativa e qualitativa sulla presenza di *Tapes philippinarum* in aree circoscritte della Laguna di Venezia e parere tecnico-scientifico sull'opportunità di effettuare una campagna di raccolta emergenziale nel periodo novembre 2006 – gennaio 2007. Relazione del 20/11/2006.
4 - G.R.A.L. - Agriteco., 2007. Valutazione dei quantitativi e della distribuzione del seme di vongola filippina *Tapes philippinarum* nelle aree nursery della laguna centrale e valutazione dei quantitativi e della distribuzione della vongola filippina *Tapes philippinarum* di taglia commerciale. Relazione del 08/03/2007.
5 - Pebesma E.J., 2004. Multivariable geostatistics in S: the 'gstat' package. *Computers & Geosciences*, 30: 683-691.
6 - Tagliapietra D., Cornello M. and Pessa G., 2007. Indirect estimation of benthic secondary production in the Lagoon of Venice (Italy). *Hydrobiologia*, 588: 205-212.
7 - Pranovi F., Libralato S., Raicevich S., Granzotto A., Pastres R. and Giovanardi O., 2003. Mechanical clam dredging in Venice Lagoon: effects on ecosystem stability evaluated with a trophic mass-balance model. *Mar. Biol.* 143: 393-403.

FISH ASSEMBLAGE OF THE MAR PICCOLO BASIN OF TARANTO (SOUTHERN ITALY): COMPOSITION AND STRUCTURE

Ermelinda Prato [1]* and Ermelinda Prato [1]
[1] CNR-IAMC, U.O.S. Taranto - linda.prato@iamc.cnr.it

Abstract
The fish assemblage of the Mar Piccolo estuary was studied from September 2007 to August 2008. Using a 50m beach seine a total of 6796 fishes, mainly juveniles, belonging to 16 families and 28 species were caught at 10 stations. The highest number of species was caught during spring-summer months while the number of specimens was highest in summer and autumn months. The most abundant species were *Atherina boyeri* (32.1% of total individuals) and *Liza aurata* (28.3%). Statistically significant variations among sampling time were detected for fish abundance, number of species, Shannon's diversity, Evenness, Margalef's Richness and Simpson indices, (ANOVA; $p < 0.001$).
Keywords: Fishes, Ionian Sea, Lagoons, Biodiversity

Introduction
European Council Directive [1], indicated the fish communities as key biological component in the assessment of the ecological status of transitional water [2, 3]. Among the estuarines areas in the Mediterranen sea, the Mar Piccolo estuary is located on the Ionian coast of Taranto (Apulia region, Italy). The present work aimed at providing an upadated list of species taking into account also the structural approach. The specific objectives of this study were: 1) relationship between the principal abiotic factors with fish assemblages; 2) description of the fish communities from a taxonomic and structural point of view. Material and Methods Sampling was performed every month from September 2007 to August 2008 during daylight hours, in ten stations: three of which were situated in the 1st Inlet, and seven in the 2nd Inlet. At each sampling station three replicates were collected. The mean temperature (°C) and salinity were measured for each sampling time considering the stations pooled values as replicates. Fish samples were collected using a 50m beach seine with a height of 5m and mesh of 2mm. The mean fish abundance (number of individual), number of species and standing stock (grams of fish biomass) were calculated. Basic community index: Shannon–Wiener's diversity, Pielou's index (*J*), Margalef's richness index (*d*) and Simpson index were recorded. Two-way analysis of variance (ANOVA) was used to assess temporal differences in total fish community.

Results and Discussion
The water temperature followed a seasonal trend, with a minimum value in December (10.5 ±0.5°C) and maximum in August (25.5± 1°C). Salinity was lowest in January (35±1‰) and highest in October (36.8 ±0.5‰). Salinity was directly related to temperature ($p<0.001$; $r= 0.71$). Multiple regressions indicated that the number of individuals and standing stock, showed no significant relationship with environmental variables ($p> 0.05$). A total of 6796 fishes belonging to 16 families and 28 species were caught. The highest number of species was caught during spring-summer months, while the number of specimens was highest in summer and autumn months. The highest number of species recorded in spring shows that this ecosystem is an important spawning and nursery area. This ecosystem supported a number of species within of the European estuaries range, 14 (Essex Coastline, UK) and 110 (Thames) species with an average (±SD) of 53 ± 20 in 38 European estuaries [4]. The most abundant species were *Atherina boyeri* (32.1% of total individuals) *Liza aurata* (28.3%), *Symphodus cinereus* (7.2%), *Zosterisessor ophiocephalus* (7.1%), *Liza saliens* (5.5%), *Engraulis encrasicholus* (2.7%), *Symphodus tinca* (2.6%) and *Sparus auratus* (2.5%). Fish abundance, number of species, Shannon's diversity, Evenness, Margalef's Richness and Simpson indices, revealed a highly significant variation among sampling time (ANOVA; $p< 0.001$). Mar Piccolo ichthyofauna includes marine euryhaline species that permanently live in the estuary, such as *A. boyeri*, *Aphanius fasciatus*, *Z. ophiocephalus*, *Gobius niger*, *G. paganellus* and *Syngnathus acus*. The ichthyofauna also includes juveniles of euryaline marine species for which this highly productive habitat provides a nursery ground (*Sparus aurata*, *Dicentrarchus labrax*, *Diplodus vulgaris*, *Sarpa salpa*, *Mullus barbatus*, *Symphodus rostratus*, *S. tinca*, *S. cinereus*, and almost all species of Mugilidae). The results obtained from this study provide a first contribute to knowledge of temporal patterns of structural fish assemblage in Mar Piccolo basin. However, due to anthropogenic pressures such as industry, fisheries and other maritime activities, it is necessary to protect and monitor this important fish habitat.

References
1 - European Council Directive., 2000. European Commission Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000. Establishing a Framework for Community Action in the Field of Water Policy. Directive 2000/60/EC of the European Parliament of the Council. *Official Journal of European Communities* 327: 1–72. Brussels.
2 - Breine J., Maes J., Quattaert P., Van den Bergh E., Simoens I., Van Thuyne G. and Belpaire C., 2007. A fish-based assessment tool for the ecological quality of the brackish Schelde estuary in Flanders (Belgium). *Hydrobiologia* 575: 141-159.
3 - Coates S., Waugh A., Anwar A. and Robson M., 2007. Efficacy of a multi-metric fish index as an analysis tool for the transitional fish component of the Water Framework Directive. *Mar. Poll. Bull*., 55: 225-240.
4 - Franco A., Elliott M., Franzoi P. and Torricelli P., 2008. Life strategies of fishes in European estuaries: the functional guild approach. *Mar. Ecol. Prog. Series*; 354:219-228.

ALIEN INVASIVE SPECIES ESTABLISHED IN FOULING COMMUNITIES FROM CONSTANTA HARBOR, ROMANIA - A PILOT STUDY

Cristina Preda [1]* and Marius Skolka [1]
[1] Ovidius University of Constanta - preda_cristina2006@yahoo.com

Abstract
In this pilot study, we monitored alien invasive species established in benthic communities from artificial hard substrata in Constanta Harbor, Romania. Aspects regarding the biodiversity of fouling communities are presented as well as the situation of different invasive species in Constanta Harbor. The study was performed as part of the MODSIS project (MOnitoring and Detection System for Invasive Species) financed within IDEI program of the National Research, Development and Innovation Plan - PN II.
Keywords: Black Sea, Monitoring, Alien species, Biodiversity

Introduction
Constanta Harbor is the largest port at the Black Sea, with a handling capacity of over 100 million tones per year. The total traffic increased from 43200 thousands tones in 2003 to 61800 in 2008 therefore increasing the risks of new alien species becoming established at the Romanian coast. The aim of this pilot study was to identify alien invasive species (AIS) "hot spots" in Constanta Harbor. We hypothesized that Constanta Harbor acts not only as a major gateway but also as an AIS reservoir.

Material and Methods
Three study sites in Constanta Harbor were selected taking in consideration the distance from the harbor entrance. First study site (S1) is closest to the entrance while the second (S2) and third (S3) are located inside the harbor (Figure 1). We collected monthly random samples from artificial substrata at 1 – 1,5 m depth from January till October 2009. Samples from ships hulls were collected occasionally in order to observe the community structure.



Fig. 1. Study sites in Constanta Harbor

Results and Discussion
We identified 67 macroinvertebrate species from fouling communities on artificial hard substrata, dominated by *Mytillus galloprovincialis* and *Brachyodontes lineatus*. Of these species, 44 are present in all sampling sites, 15 are current in two sites while 7 species occur only in one of the sites. Minor differences were reported between the qualitative structure of artificial and natural hard substrata communities [1] and also between the three sampling sites. AIS represent about 9%, all of them previously mentioned from the Romanian Black Sea Coast [2]. However, samples from ship hulls contain more alien species that represent a permanent source of potential settlers as is the case of other areas in the north-western Black Sea [3] (Table 1).

Tab. 1. AIS identified in samples

Species	Origin	Year of the first mention	Presence in fouling communities	Situation
Blackfordia virginica	North Atlantic	1940	S1	Established
Haliplanella lineata	North Atlantic	1960	S1,S2,S3	Established
Hydroides elegans	Indo Pacific	?	Ships fouling	Accidental
Hydroides norvegicus	North Atlantic	?	Ships fouling	Accidental
Ficopomatus enigmaticus	North Atlantic	1954	Ships fouling S2	Accidental
Doridella obscura	North Atlantic	1997	S1,S2,S3	Established
Mya arenaria	North Atlantic	1968	S2,S3	Established
Musculista senhousia	Indo Pacific	2004	Ships fouling	Accidental
Balanus improvisus	North Atlantic	1844	S1,S2,S3	Established
Balanus amphitrite	North Atlantic	1954	Ships fouling	Accidental
Sphaeroma walkeri	Indo Pacific	2004	Ships fouling	Accidental
Lepas sp.	Atlanto-mediterranean	?	Ships fouling	Accidental
Rhitropanopeus harrisii	Indo Pacific	1950	S1,S2,S3	Established

Conclusion
The AIS identified in our samples are well integrated in the fouling communities therefore the harbor acts as an AIS reservoir for neighboring areas.

References
1 - Micu D. and Micu S., 2004. A new type of macrozoobenthic community from the rocky bottoms of the Black Sea. International Workshop On the Black Sea Benthos, 18-23 April 2004, Instanbul-Turkey.
2 - Alexandrov B., Zaitsev Y. and Ozturk B., 2001. The Black Sea. *In*: Zaitsev Y. and Ozturk B. (ed), Exotic Species in the Aegean, Marmara, Black, Azov and Caspian Seas. Turkish Marine Research Foundation, Istanbul, pp 73-138.
3 - Alexandrov B., Boltachev A., Kharchenko T., Lyashenko A., Son M., Tsarenko P. and Zhukinsky V., 2007. Trends of aquatic alien species invasions in Ukraine. *Aquatic Invasions*, 2(3): 215-242.

DIFFERENTIAL GENE EXPRESSION PROFILING UNDER DIFFERENT LIGHT CONDITIONS IN *POSIDONIA OCEANICA* (*L.*) DELILE BY SSH ANALYSIS

G. Procaccini [1]*, E. Dattolo [1], A. M. Innocenti [2], S. Mazzuca [2], A. Cavallini [3], L. Natali [3], J. Gu [4] and P. Bayer [4]
[1] Stazione Zoologica Anton Dohrn - gpro@szn.it
[2] Dipartimento di Ecologia, Università della Calabria, Arcavacata di Rende (CS), Italy
[3] Dipartimento di Biologia delle Piante Agrarie, Università di Pisa, Pisa, Italy
[4] Institute for Evolution and Biodiversity, University of Muenster, Huefferstrasse 1, D48149 Muenster, Germany

Abstract
A SSH (Suppression Subtractive Hybridization) cDNA library was constructed using samples collected from a continuous *Posidonia oceanica* meadow located in *Lacco Ameno* (Ischia, Gulf of Naples) at two different depths (-5 and -25 m). The aims are to identify differentially expressed genes associated with different light and temperature regimes and other potential stress-responsive gene networks important for adaptation. With ~1200 sequenced cDNA clones, 486 tentative unigenes were identified, of which only 28 are common to both shallow and deep libraries. Genes have been grouped in functional classes showing the highest differences between the two depths in primary metabolism, photosynthesis and stress defence genes.
Keywords: Genetics, Global Change, Phanerogams, Posidonia

Introduction
Seagrass meadows are among the most productive ecosystems [1] with *Posidonia oceanica* being the most important species in the Mediterranean coastline. This species forms extensive mono-specific meadows that are extremely sensitive to medium-high levels of disturbance [2] and are being threatened by fast environmental changes caused by global warming and increasing human activities. Collectively, the forces impose a strong selective pressure to the long living *P. oceanica* meadows, particularly those found at the extremes of the environmental and geographic limits of the species. Being sessile, seagrasses can not easily disperse from a given locality and must therefore adapt to selective regimes and acclimatize to variations in local environmental parameters. The goal of this study it to distinguish differentially expressed genes associated with different light and temperature regimes and to identify potential stress-responsive gene networks. In order to do that, we built a SSH cDNA library between two different depths (-5 and -25 m) in a continuous *P. oceanica* meadow located in *Lacco Ameno* (Ischia, Gulf of Naples). Existing data suggest that clones growing at different depths are genetically isolated and that plants growing above and below the summer thermocline experience strong differences in light and temperature exposure [3].

Material and Method
After the stabilization of the summer thermocline (about -15m depth), shoots were collected above and below this thermocline by SCUBA diving from a meadow located in Lacco Ameno, Ischia (Gulf of Naples) in July 2008. Plants found at -5m (shallow station) and -25m (deep station) depth were sampled. Total RNA were isolated from leaf tissue using a modified hexadecyltrimertihyl bromide (CTAB) method; poly(A+) mRNA was isolated from the total RNA using the Dynabeads mRNA Purification kit (DYNAL BIOTECH), and forward and reverse SSH libraries were built using the PCR-select cDNA subtraction kit (Clontech, Palo Alto, CA). A total of 1920 random clones (960 from the shallow and 960 from the deep library) were sequenced in double-strand (Richard Reinhardt, MPI Molecular Genetics, Berlin, Germany). EST raw sequences were quality-trimmed and assembled into tentative gene clusters (TC) using CAP3 [4]. Putative functions of the identified tentative unigenes (TUG), were assessed by performing homology searches against the following databases: Gene Ontology(GO), SWISSPROT, NR -NCBI (blastx-step, e-value 0.001) and DrZompo (blastn-step).

Results and Discussion
The final assembly of shallow and deep ESTs includes 486 TUGs with a successful mapping of 2279 ESTs. 364 ESTs could not be assigned to the TUGs library. The percentage of TUGs common to both libraries (shallow and deep, S and D) was only 5.86% (28/486); 205 TUGs were found in S while 309 TUGs were found in D. TUGs have been divided in seven functional categories, the percent abundance of which differed in the two libraries. Transcripts for Protein Turnover and Respiration are more abundant in S, suggesting a more rapid metabolism at higher irradiance, while transcripts for the other five categories are more abundant in D (Fig. 1).

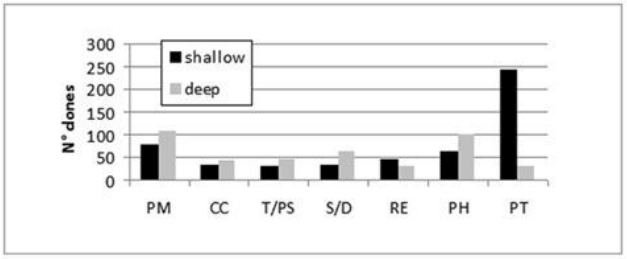


Fig. 1. Total number of ESTs assigned to functional categories. PM: Protein Metabolism; CC: Cell Component; T/PS : Transcription/Protein Synthesis; S/D : Stress/Defense; RE: Respiration; PH: Photosynthesis; PT: Protein Turnover

The presence of a higher number of transcripts assigned to Photosynthesis in the deep station is noteworthy, suggesting that a more complex and functional photosynthetic apparatus at lower irradiance is needed. Different stress responsive genes are present in the two libraries.

References
1 - Costanza R., d'Arge R., de Groot R., Farber S., Grasso M., 1997. The value of the world's ecosystem services and natural capital. *Nature*, 387: 253-260.
2 - Procaccini G., Buia MC., Gambi M.C., *et al.*, 2003. Seagrass status and extent along the Mediterranean coasts of Italy, France and Spain. *In*: Green E.P., Short F.T. (eds.), World Atlas of Seagrasses, Univ. of California Press, Berkeley, pp 48-58.
3 - Migliaccio M., De Martino F., Silvestre F. and Procaccini G., 2005. Meadow-scale genetic structure in *Posidonia oceanica* L. (Delile). *Mar. Ecol. Prog. Series*, 304: 55-65.
4 - Huang X. and Madan A., 1999. CAP3: A DNA sequence assembly program. *Genome Res.*,9(9): 868-77.

IMPACT OF ENVIRONMENTAL FACTORS ON THE DISTRIBUTION AND DENSITY OF FAN MUSSEL *PINNA NOBILIS* ALONG THE EASTERN AND SOUTH-EASTERN TUNISIAN COASTLINE

Lotfi Rabaoui [1]*, Sabiha Tlig-zouari [1], Stelios Katsanevakis [2] and Oum kalthoum Ben hassine [1]

[1] Faculty of Science of Tunis, University Campus, Biology department. El Manar 2092, Tunis – TUNISIA - lrabaoui@gmail.com

[2] Institute of Marine Biological Resources, Hellenic Centre of Marine Research, 46.7 km Athens-Sounio, 19013 Anavyssos, GREECE

Abstract

The distribution and density of *Pinna nobilis* was estimated along the eastern and south-eastern Tunisian coasts, with the use of a density surface modelling (DSM) approach. A marked relationship between the fan mussel density and two spatial parameters (depth and distance from a pollution source) was revealed. The adopted technique was found advantageous to better understand the ecology of the species.

Keywords: Pollution, Sampling Methods, Density

Introduction

Pinna nobilis is a Mediterranean endemic species. It is the largest Mediterranean bivalve which occurs in coastal soft-bottom areas, usually in association with seagrass meadows [1]. It is also one of the Mediterranean endangered species. To effectively protect this mollusc, it is necessary to assess the status and distribution of all major local *P. nobilis* populations.

Material and Methods

In the present study, a distance sampling method was applied to model the population distribution and density of *P. nobilis* along the eastern and south-eastern Tunisian coastline (from Hergla to Elketef) taking into account spatial and environmental parameters. To do so, forty five line transects, perpendicular to the shoreline and extending from 0 to 6 m depth, were defined randomly along the study area; each line transect was marked every meter and divided into 8-m segments. After deploying the line, all detected *P. nobilis* individuals within 150 cm from the line were counted. For each observed individual, the following variables were recorded: the corresponding segment in which it was found, the perpendicular distance from the line (= y_i), and the shell size (= s_i), defined as the maximum dorso-ventral length of the shell. In addition, at the mid-point of each segment of the line transect the exact depth was measured. The dominant habitat type (*H*) of each segment was also recorded. Six different habitat types were identified: unvegetated sandy/muddy bottoms (UN), *Posidonia oceanica* beds (PO), *Cymodocea nodosa* beds (CN), *Caulerpa prolifera* beds (CP), *Caulerpa racemosa* beds (CR), and *Zostera noltii* beds (ZN).

For the detection function modelling, two functions were considered as candidate detection functions: the one-parameter half-normal function $\hat{g}(y) = exp\left(\frac{-y^2}{2\sigma^2}\right)$ and the two-parameter hazard-rate function $\hat{g}(y) = 1 - exp\left[-\left(\frac{y}{\sigma}\right)^{-b}\right]$, where σ is a scale parameter and b a shape parameter. Considering different conditions, eight models were included in the set of candidate models and the selection between them was based on the small-sample, bias-corrected form AIC_c of the Akaike Information Criterion. The population density of *P. nobilis* was modelled using the 'count method' of [2]. For that, one categorical and two continuous potential predictor variables were used: habitat type (*H*), depth (*d*), and the distance of each site (along the coastline) from the city of Gabes (*x*) respectively. Negative values were given to *x*'s southwards and positive values for *x*'s northwards of Gabes. With respect to the considered variables, eight models were used and model selection was done based on GCV score.

Results

A total of 318 fan mussel individuals were recorded in the line transects. The best model of the detection function among those tested (based on AIC_c) was the half normal function with no scale covariate. It is given by the equation $\hat{g}(y) = exp\left(\frac{-y^2}{2\sigma^2}\right) = exp\left(-1.602y^2\right)$, where distance from line (*y*) is in m. The best density model was the model which included univariate functions of depth (*d*) and the distance from the city of Gabes (*x*). The expression of this model was $ln\left(E\left[\hat{n}_i\right]\right) = c + s_1(d) + s_2(x) + ln(\alpha)$, where c = -20.0, *a* = 18.4 m^2, and the smooth functions s_i are given in Figure 1.

The fan mussel population density was zero at very shallow waters (<0.3 m depth) and was increasing within the depth range of this study (0–6 m). Zero fan mussel densities were observed near the city of Gabes. Population density increased with the distance from the city of Gabes and was higher in the south than in the north.

Discussion

Pinna nobilis density-depth correlation is well known with the fan mussel. Similar results were noted in Spain [3] and in Greece [4]. Regarding the relationship between the fan mussel density and the distance from Gabes city, this correlation could be attributed to pollution. Among the big cities located in the Gulf of Gabes (Gabes, Sfax, and Skhira), Gabes city is considered as the main source of pollutants, in particular phosphogypsum discharge in the open sea. According to figure 2, the farer from Gabes city the higher was *P.nobilis* population density. Almost all transects close to Gabes city had null densities. The absence of *Pinna nobilis* from the coast of Gabes and surrounding coasts is probably due to the large quantities of phosphogyps wasted from the industries of phosphoric acid and chemical products in the open sea since the seventies [5].

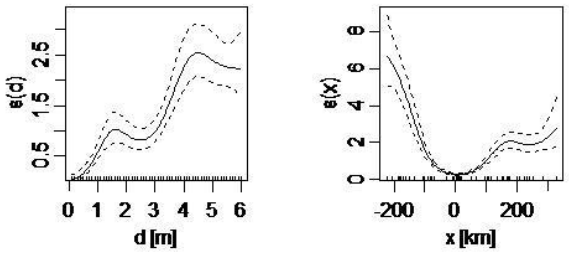


Fig. 1. Estimated smooth terms *s(d)* and *s(x)*, for the best model of *Pinna nobilis* abundance in the study area. The smooth terms are given in the response scale and the corresponding 95% confidence intervals are given with dotted lines. A one-dimensional scatterplot is given at the bottom of each graph, using a vertical bar as the plotting symbol, to illustrate the distribution of available data

References

1 - Zavodnik D., Hrs-Brenko M. and Legac M., 1991. Synopsis on the fan shell *Pinna nobilis* L. in the eastern Adriatic Sea. In: Boudouresque C.F., Avon M., Gravez V. (ed.), Les Espèces Marines à Protéger en Méditerranée. GIS Posidonie publ., Marseille, pp 169–178.

2 - Hedley S.L., Buckland S.T. and Borchers D.L., 2004. Spatial distance sampling models. In: Buckland S.T., Anderson D.R., Burnham K.P., Laake J.L., Borchers D.L. and Thomas L. (ed.), Advanced distance sampling: estimating abundance of biological populations. Oxford University Press, New York, pp 48–70.

3 - García-March J.R., García-Carrascosa A.M., Pena Cantero A.L. and Wang Y.G., 2007. Population structure, mortality and growth of *Pinna nobilis* Linnaeus, 1758 (Mollusca: Bivalvia) at different depths in Moraira bay (Alicante, Western Mediterranean). *Mar. Biol.*, 150: 861–871.

4 - Katsanevakis S., 2007. Density surface modelling with line transect sampling as a tool for abundance estimation of marine benthic species: the *Pinna nobilis* example in a marine lake. *Mar. Biol.*, 152: 77-85.

5 - Zaghden H., Kallel M., Louati A., Elleuch B., Oudot J. and Saliot A., 2005. Hydrocarbons in surface sediments from the Sfax coastal zone (Tunisia), Mediterranean Sea. *Mar. Poll. Bull.*, 50: 1287–1294.

PERCNON GIBBESI (H. MILNE EDWARDS, 1853) IN LINOSA ISLAND TEN YEARS AFTER ITS FIRST RECORD

Paolo Raineri [1] and Dario Savini [1]*

[1] Dipartimento di Ecologia del Territorio, University of Pavia, Via S. Epifanio 14 I-27100 Pavia - dario.savini@unipv.it

Abstract

An extensive survey conducted by visual census in summer 2009 by snorkelling and scuba diving reports a complete acclimation of the alien invasive grapsid crab *Percnon gibbesi* in Linosa Island (MPA Isole Pelagie, Sicily). The crab is distributed from 0-11 m depth along the whole littoral with the exception of one locality. Population density values ranges from a minimum of 1 to a maximum of 51 ind. per $10m^2$ of seabottom.

Keywords: Decapoda, Islands, Sicilian Channel, Monitoring

Introduction

The alien crab *Percnon gibbesi* was firsty recorded in the Mediterranean in Linosa island in summer 1999 [1]. Since then it has been fastly spreading in several localities of the W and E Mediterranean [2] both by natural range expansion (water currents) and by anthropogenic vectors of introduction (ship ballast waters, fishing and recreational vessels). This algivorous species has been claimed to interact negatively with the native crabs community in the mediolittoral and upper infralittoral fringes, in particular with *Pachygrapsus marmoratus*, partially occupying its ecological niche [3,4]. The present poster reports results of a survey on *P. gibbesi* distribution and abundance in Linosa Island (MPA Isole Pelagie, Sicily) ten years after its first record.

Material and Methods

From 10/08-4/09/2009 the whole perimeter of Linosa island (about 11 km coastline) was surveyed by visual census (scuba diving and snorkelling) at a depth from 0-4 m. Presence/absence of *P. gibbesi* was reported in relation to habitat type (e.g. depth, sea bottom geomorphology, algal cover). Moreover, an estimate of population density was performed in 7 localities of the island (Fig. 1). Densities were estimated by counting numbers of crabs present on a 2 x 5m ($10 m^2$) surface area of the seabottom (5 minutes search per 8 replicates). The non-parametric Kruskal Wallis test was used to compare median density values among sites [5].

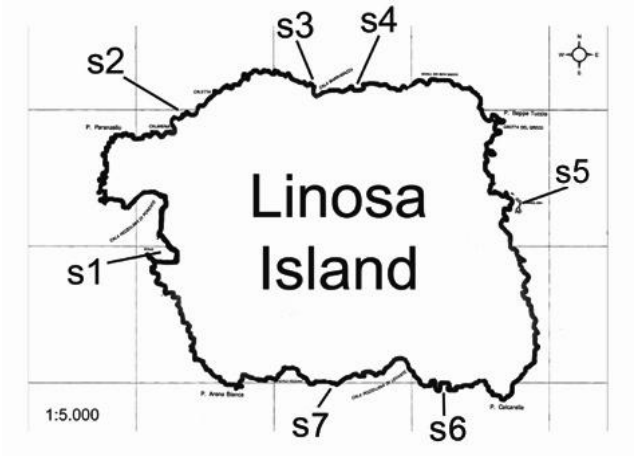


Fig. 1. Geographical location of the sites surveied for *P. gibbesi* population density

Results and discussion

P. gibbesi was recorded along all the island littoral from 0 – 4 m depth except into one locality (Grotta dell'Amore; DDD= 35.871890N;12.853768E). Population density values were significantly (KS test: H = 40.9; Df = 6; $p < 0.001$) higher in S6 (Fili - DDD= 35.855214N;12.876449E; av density= 30 ± 22 ind. $10m^{-2}$) and S7 (Casotto – DDD= 35.855440N;12.866664E; av density= 51 ± 28 ind. $10m^{-2}$) (Fig. 2). The grapsid crab clusters in typical habitats constituted by large boulders encrusted with coralline algae (e.g. *Mesophyllum* sp; *Amphiroa* sp).

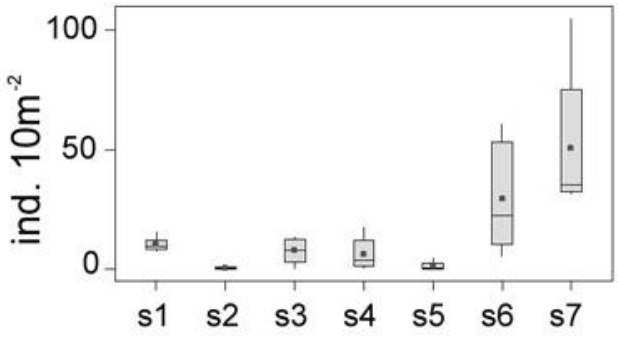


Fig. 2. Box plots of *P. gibbesi* population density values. The black points show mean density value per site. Boxes represent the 50% range of values. Whiskers represent the lower and the highest values and the lines inside the boxes represents the median value

It showed a continuous feeding activity near refugees constituted by holes and crevices in rocks. In various occasions it was found scavenging on *Pelagia noctiluca* and *Pachygrapsus marmoratus* carrions, as reported in other Mediterranean islands [6]. In conclusion, the survey identifed a well acclimated population of *P. gibbesi* in Linosa island, that in ten years has been able to colonize the whole superior infralittoral fringe, reaching higher densities (30-50 ind. $10m^{-2}$) in localities characterised by a microhabitat of large boulders covered by coralline algae. Notwithstanding the species is mainly found in a depth range of 0-4 m, in agreement with the existing literature [4,6,7] we report also a population of the invasive crab at higher depth (10.7m), in a famous scuba diving site of the island (Manarazza - DDD = 35.874516N; 12.865639E). Future studies will consider interaction of *P. gibbesi* with native fauna (e.g. competition for space and food with *P. marmoratus*, *Eriphia verrucosa*, *Arbacia lixula*, *Thalassoma pavo*, *Coris julis*) and flora (e.g. herbivory rates on coralline algae), in order to estimate the environmental impact of this species.

References

1 - Relini M., Orsi L., Puccio V. and Azzurro E., 2000. The exotic crab *Percnon gibbesi* (H.Milne Edwards, 1853) (Decapoda, Grapsidae) in the Central Mediterranean. *Sci.Mar*., 64: 337-340.

2 - Galil B., Froglia C. and Noël P., 2002. CIESM Atlas of exotic species in the Mediterranean. Vol. 2. Crustaceans, 192 pp.

3 - Cannicci S., Gomei M., Boddi B. and Vannini B., 2002. Feeding habits and natural diet of the intertidal crab *Pachygrapsus marmoratus*: opportunistic browser or selective feeder? *Estuar. Coast. Shelf Sci.*, 54: 983 -1001.

4 - Puccio V., Relini M., Azzurro E. and Orsi Relini L., 2006. Feeding habits of *Percnon gibbesi* (H. Milne Edwards, 1853) in the Sicily Strait. *Hydrobiol.* 557: 79-84.

5 - McKenzie J.D. and Goldman R.N., 1999. The student edition of Minitab for Windows 95 and Windows NT. Addison-Wesley, Reading.

6 - Cannicci S., Badalamenti F., Milazzo M., Gomei M., Baccarella A. and Vannini M., 2004. Unvailing the secrets of a succesfull invader: preliminary data on the biology and the ecology of the crab *Percnon gibbesi* (H. Milne Edwards, 1853). Rapp.Comm.int.Mer Médit., 37: 326.

7 - Sciberras M. and Schembri P.J., 2007. Observations on the alien crab *Percnon gibbesi* (Decapoda, Brachyura, Grapsidae) from the maltese islands. Rapp. Comm. int. Mer Médit., 38: 594.

CARACTERISATION DES PEUPLEMENTS ALGAUX ASSOCIES AUX TROTTOIRS A VERMETS EN ALGERIE

Chafika Rebzani Zahaf [1]* and Amina Karali [1]

[1] Faculté des Sciences Biologiques (FSB) Université Sciences et Technologie. Houari Boumedienne (USTHB), Alger, 16111, Algérie - chafikarebzanizahaf@gmail.com

Abstract

L'étude des différents types de bioconcrétions de la région de Tipaza a permis de localiser des trottoirs à vermets, des bourrelets à *Corallines* et des encorbellements à *Lithophyllum*. L'analyse de la biodiversité des trottoirs à vermets, effectuée en 2008-2009, a recensé au total 64 espèces floristiques.

Keywords: Biodiversity, Bio-Indicators, Phytobenthos, Zoobenthos

Introduction : Les bioconcrétionnements sont des biocénoses remarquables en Méditerranée. L'aspect écologique des trottoirs à vermets et la flore qui lui est associée sont étudiés. Ces formations biologiques sont rencontrées au niveau de l'étage médiolittoral inférieur et infralittoral supérieur sur les côtes rocheuses particulièrement de mode battu. Ces bioformations ont été signalées au niveau de la région de Tipaza par plusieurs auteurs, mais n'ont pas fait l'objet d'étude antérieure en Algérie. La présente étude concerne les types de bioconcrétionnements médiolittoraux et ceux de la partie supérieure infralittorale. Leurs localisations, leurs morphologies, ainsi que les espèces bioconstructrices et l'épaisseur de la couche édifiée ont été traités.

Matériels et méthodes

Les trois sites étudiés, Ain Tagourait, Kouali et Chenoua, sont localisés dans la partie Ouest de la région de Tipaza; cinq prélèvements ont été effectués en périodes estivale et hivernale (juillet-août 2008 ; janvier-février 2009). La méthode d'échantillonnage repose sur celle adoptée par Bellan-Santini [1] qui consiste en un grattage total jusqu'à la roche de surface (20x20 cm). L'ensemble de la récolte est versé sur un tamis de 1 mm de maille, recueilli, trié et conservé dans de l'eau de mer formolée à 4%.

Résultats et discussions : 1 - Les bioconcrétionnements : À Ain Tagourait, trois espèces bioconstructrices de trottoirs à vermets ont été observées : *Dendropoma petraeum, Vermetus triqueter* et *Lithophyllum incrustans*. À Kouali, deux types de constructions biologiques ont été observés : les trottoirs à vermets édifiés par les mêmes espèces rencontrées à Ain Tagourait et des bourrelets à *Corallina elongata*. Au Chenoua, les trottoirs à vermets rencontrés sont édifiés par *Dendropoma petraeum* et *Neogoniolithon sp*, des encorbellements à *Lithophyllum lichenoides* sont également observés. Les épaisseurs moyennes des trottoirs à vermets sont de : 4,58 cm à Ain Tagourait, 6,1 cm à Kouali et de 5 cm au Chenoua. Les phénomènes responsables des faibles valeurs des amplitudes horizontales des encroûtements sont : - une mince couche de vermets qui couvre les trottoirs en Algérie et en Sicile ; soit entre 5 et 10 cm d'amplitude horizontale [8] . Les résultats de l'étude montrent que le groupe des Photophiles Infralittoral Calme est aussi dominant que celui des Photophiles Infralittoral de mode Battu ; selon Molinier [7], plus la côte est battue, plus l'épaisseur des vermets est importante. Par conséquent, le faible hydrodynamisme ne favorise pas le développement des vermets ; - les espèces édificatrices des trottoirs sont très sensibles à la pollution, la présence massive de certaines algues dont les ulvales et les corallinales (*Corallina elongata*) indiquent une altération du milieu [5] ; - les piétinements (public, pêcheurs, estivants et touristes), ces plates-formes sont en général très fréquentées. **2 - La flore :** Les espèces algales déterminées sont aux nombres de 64 sur l'ensemble des trois sites étudiés ; 40 espèces appartiennent aux rhodophytes, 13 espèces aux chromophytes et 11 espèces aux chlorophytes pendant les deux saisons. Les espèces les plus représentatives sont les rhodophytes *(Corallina elongata, Jania rubens)* récoltées en épiphyte. *Neogoniolithon sp* est rencontrée uniquement au Chenoua, elle est en étroite association avec les *Dendropoma petraeum* pour édifier les concrétions. *Hypnea musciformis* est classée Photophile Infralittorale Thermophile par Boudouresque [3], elle forme des faciès et prolifère surtout en été. Selon Laborel [6], Bellan-Santini [2], Chemello [5], les espèces bioconstructrices de trottoirs à vermets sont apparentées à des eaux tempérées relativement chaudes. Pour les chromophytes, *Cystoseira stricta* forme des ceintures, et indique une eau pure, son recouvrement à Chenoua est moindre. Les chlorophytes (les ulves et les enteromorphes) se développent essentiellement à proximité des zones anthropisées ou fortement fréquentées, et sont donc des espèces indicatrices d'eaux polluées [1]. Les résultats du rapport R/P obtenus oscillent entre 2,62 à 3 et témoigneraient de la présence d'un peuplement à affinité relativement tempérée à chaude, cette affinité permet le bon développement des vermets.

Conclusion

Les bioconcrétionnements littoraux sont étudiés pour leurs intérêts écologiques et économiques, ce sont des processus très lents et rares en Méditerranée, ces biocénoses remarquables abritent une flore diversifiée servant de lieu de frayère et de nurserie pour de nombreuses espèces animales. Compte tenu de la lenteur et de la rareté de ces constructions biogéniques, le monitoring de ces peuplements semble indispensable à l'échelle méditerranéenne. Les trottoirs à vermets sont très sensibles à la pollution d'où la nécessité d'élaborer des plans de gestion et de conservation en rassemblant des données scientifiques précises et actualisées. La mise en place d'une base de données et d'une stratégie de surveillance, de conservation et d'un plan de gestion, sont indispensables. Dans une perspective préventive, il est nécessaire de procéder à la préservation de ces bioformations fragiles. Cette étude a permis de conclure que le site de Chenoua est le plus vulnérable. La biosurveillance, grâce à la cartographie de tous les bioconcrétionnements des côtes algériennes et aux mesures biométriques, reste le moyen le plus sur et le plus efficace pour la protection des habitats remarquables ainsi que des agents biologiques responsables de ces bioconstructions. Cette étude a révélé l'« état à temps zéro » et les mesures biométriques des trottoirs ; un suivi régulier de leur évolution ou de leur régression est indispensable à la sauvegarde et à la protection du patrimoine naturel de ces sites. Pour la conservation des types d'habitats marins naturels et remarquables et sur la base de critères méditerranéens, des fiches techniques d'évaluation écologique ont été établies pour chaque site. Ces fiches synthétisent les données scientifiques recueillies, et serviront à fournir des documents, à l'usage des gestionnaires, de prise de mesures de protection et de conservation.

References

1 - Bellan-Santini D., 1969. Contribution à l'étude des peuplements infralittoraux sur substrat dur rocheux (Etude qualitative et quantitative de la frange supérieure) *Rec. Trav. St. mar*. Endoume, fasc.63, *Bull*. 47 : 5-294p.

2 - Bellan-Santini D ; Lacaza J. C ; Poizat C., 1994. Les biocénoses marines et littorales de Méditerranée, synthèse, menaces et perspectives. *Mus. Natn. His. Nat.*, Paris, 246p.

3 - Boudouresque C. F., 1984.Groupes écologiques d'algues marines et phytocénoses benthiques en Méditerranée nord-occidentale *: Une revue Gior. Bot. Ital.*, 118(suppl.2) : 7-42.

4 - Boudouresque C.F. et Ballesteros E., Ben Maiz N. N., Boisset F., Bouladier E., Cinelli F., Cirik., Cormaci M., Jeudy de Grissac A., Laborel J., Lanfranco E., Lundberg B., Mayhoub H., Meinesz A., Panayotidis P., Semroud R., Sinnassamy J. M., Span A., Vuignier G., 1990. Livre rouge "Gérard Vuignier" des végétaux, peuplements et paysages marins menacés de Méditerranée. Programme des Nations Unies pour l'Environnement publ.: 250pp.

5 - Chemello.R., Dieli T., Antonioli F., 2000. Il ruolo dei "reef" a Molluschi Vermitidi nella valutazione della biodiversità. *"Mare e cambiamenti globali"* . 105-118p.

6 - Laborel.J., 1980. Les gastéropodes Vermetidés : leur utilisation comme marqueurs biologiques de rivages fossiles. Oceanis. Vol.5. fasc. Hors-série : 221-239.

7 - Molinier R., 1955. Les plates formes récifales de vermets (*Vermetus cristatus Biondi*) en Méditerranée occidentale. Biologie marine (240) : 361-363.

8 - Peres J.M., Picard J., 1964. Manuel des bionomies benthiques de la Méditerranée. *Rec. Trv. St. Mar. Endoume* : 1-137.

9 - Templado J., Calvo. M., 2006. Flora y fauna de la reserva marina y reserva de pesca de la isla de Alboran: 58-60.

BIONOMIE BENTHIQUE DES PEUPLEMENTS ICHTYOLOGIQUES DES FONDS CHALUTABLES DU SECTEUR ORIENTAL DE LA COTE ALGERIENNE

Wahid Refes [1]*, Nadia Semahi [1] and Mostefa Boulahdid [1]

[1] Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral, 16000, Alger, Algérie - wrefes@hotmail.com

Abstract

Ce travail est une synthèse des observations réalisées sur la faune ichtyologique des fonds chalutables du secteur oriental de la côte algérienne au cours de la période 2005-2006. Il a permis de recenser 201 espèces de poissons, dont les peuplements ichtyologiques se structurent en trois unités bionomiques : le peuplement du détritique côtier à *Vidalia volubilis* ou à *Ophiura texturata* ; le peuplement du détritique du large à *Leptometra phalangium* ou à *Neolampas rostellata* ; le peuplement des vases bathyales à *Funiculina quadrangularis* et *Aporrhais serresianus* ou à *Isidella elongata* et à *Thenea muricata*.

Keywords: Algerian Basin, Fishes, Zoobenthos

Introduction

À l'exception des travaux de Maurin *et al.* [1] sur la bionomie benthique des peuplements ichtyologiques du talus continental de la partie orientale de la côte algérienne (région d'El Kala, golfe d'Annaba, golfe de Skikda, golfe de Béjaïa), réalisés lors de la campagne de pêche du « Président Théodore-Tissier » en 1960, on ne recense aucun travaux sur cette thématique par la suite en Algérie. Cette étude présente une image récente et actualisée de la bionomie des peuplements ichtyologiques des fonds chalutables du secteur oriental de la côte algérienne.

Matériel et méthodes

Le secteur oriental de la côte algérienne s'étend de Cap Segleb (36°56'45''N – 8°36'57''E) à Cap Carbon (36°46'36''N – 5°06'27''E), il regroupe la région d'El Kala, le golfe d'Annaba, le golfe de Skikda, la baie de Jijel et le golfe de Béjaïa. Les résultats présentés sont des observations réalisées régulièrement et tout au long de l'année entre 2005 et 2006 lors de campagnes de pêche réalisées, à bord de chalutiers professionnels, par recensement des poissons et de la mégalofaune benthique accompagnatrice sur des fonds compris entre 22 et 795 mètres.

Résultats et discussion

Dans ce travail, les investigations, réalisées sur les fonds chalutables du secteur oriental de la côte algérienne entre 2005 et 2006, ont permis de recenser 201 espèces soit 29 Chondrichthyes et 172 Osteichthyes. Une classification ascendante hiérarchique est réalisée sur une matrice de 47 espèces constantes (*B. boops ; C. conger ; M. merluccius ; M. barbatus ; P. acarne ; P. bogaraveo ; T. trachurus ; T. lyra*) et communes (*A. m. mediterranea ; A. sphyraena ; A. hemigymnus ; A. laterna ; A. rueppelli ; A. cuculus ; A. obscura ; C. aper ; C. rubescens ; C. agassizii ; C. linguatula ; C. coelorhynchus ; D. maroccanus ; D. annularis ; E. encrasicolus ; E. denticulatus ; E. spinax ; G. a. argenteus ; G. melastomus ; H. d. dactylopterus ; H. mediterraneus ; L. caudatus ; L. boscii ; L. cavillone ; L. budegassa ; M. scolopax ; M. poutassou ; M. surmuletus ; P. erythrinus ; P. blennoides ; R. asterias ; R. miraletus ; R. oxyrinchus ; S. pilchardus ; S. aurita ; S. scombrus ; S. smaris ; U. scaber ; Z. faber*) sur le suivi des 59 traits de chalut effectués lors des campagnes de 2005-2006, en utilisant la distance euclidienne et la méthode de Ward comme critère d'agrégation. Il ressort de cette analyse la présence de trois ensembles ichtyologiques : - un ensemble côtier entre 20 et 200 mètres comprenant le plateau continental et le bord supérieur du talus ; il est caractérisé par un cortège de 5 espèces constantes (*M. barbatus ; P. acarne ; B. boops ; T. trachurus ; Trigla lyra*) et 8 espèces communes (*P. erythrinus ; A. m. mediterranea ; E. encrasicolus ; S. pilchardus ; D. maroccanus ; C. linguatula ; M. surmuletus ; Z. faber*). - un ensemble profond entre 200 et 795 mètres ; il est caractérisé par un cortège de 13 espèces communes (*E. spinax ; G. melastomus ; H. mediterraneus ; C. coelorhynchus ; E. denticulatus ; L. caudatus ; P. blennoides ; R. oxyrinchus ; C. agassizii ; G. a. argenteus ; H. d. dactylopterus ; M. poutassou ; A. hemigymnus*). - un ensemble à large répartition bathymétrique ; il rassemble 3 espèces constantes (*M. merluccius ; C. conger ; P. bogaraveo*) et une espèce commune (*L. cavillone*). Ces observations confirment les résultats obtenus en Méditerranée par Stefanescu *et al.* [2] et Tserpes *et al.* [3]. Ils ont mis en évidence une forte relation entre l'assemblage des poissons et la profondeur. Il en est de même pour l'ensemble de la macrofaune et mégalofaune benthiques et démersales [4], [5], où la bathymétrie est un des principaux critères de ségrégation de l'organisation des peuplements. Par contre, une zonation géographique des peuplements ichtyologiques étudiés entre les différentes zones (région d'El Kala – golfe d'Annaba – golfe de Skikda – baie de Jijel – golfe de Béjaïa) n'a pas pu être mis en évidence par rapport à l'ensemble des traits de pêche réalisés dans le secteur oriental de la côte algérienne, malgré l'écart longitudinal entre la région d'El Kala et le golfe de Béjaïa de plus de 3°. Sur la base des travaux de Pérès et Picard [6], les fonds chalutables sont organisés en trois unités bionomiques de la côte vers le large : - le peuplement du détritique côtier à *Vidalia volubilis* ou à *Ophiura texturata*, où les espèces caractéristiques sont *P. acarne* et *P. erythrinus*, ainsi que les espèces *B. boops, M. barbatus, M. surmuletus* et *Z. faber*. - le peuplement du détritique du large à *Leptometra phalangium* ou à *Neolampas rostellata*, où les espèces caractéristiques sont *M. scolopax* et *T. lyra*, ainsi que *M. barbatus*. - le peuplement des vases bathyales à *Funiculina quadrangularis* et *Aporrhais serresianus* ou à *Isidella elongata* et à *Thenea muricata*, où les espèces caractéristiques sont *C. agassizii, C. coelorhynchus, E. spinax, G. melastomus, H. d. dactylopterus, L. caudatus, M. poutassou* et *P. blennoides*, ainsi que *C. aper*. Cette structuration bionomique, des peuplements ichtyologiques des fonds chalutables du secteur oriental de la côte algérienne, est liée essentiellement à la nature sédimentaire des fonds.

References

1 - Maurin C., 1968. Ecologie ichtyologique des fonds chalutables atlantiques (de la baie ibéro-marocaine à la Mauritanie) et de la Méditerranée occidentale. *Revue Travaux Institut Pêches Maritimes*, 32(1), 218p.

2 - Stefanescu C., Lloris D., Rucabado J., 1992. Deep-living demersal fishes in the Catalan Sea (western Mediterranean) below a depth of 1000 m. *Journal Natural History*, 26 : 197-213.

3 - Tserpes G., Peristeraki P., Potamias G., Tsimenides N.,1999. Species distribution in the southern Aegean sea based on bottom-trawl surveys. *Aquatic living Resources*, 12(3) : 167-175.

4 - Abello P., Valladares F.J., Castellon A., 1988. Analysis of the structure of decapods crustacean assemblages off Catalan coast (north-west Mediterranean). *Marine Biology*, 98 : 39-49.

5 - Gaertner J.C., Bertrand J.A., Samani D., Souplet A.,2005. Spatio-temporal organization patterns of demersal assemblages of the east coast of Corsica (Mediterranean sea). *Vie et Milieu*, 55(2) : 81-89.

6 - Pérès J.M., Picard J., 1964. Nouveau manuel de bionomie benthique de la Mer Méditerranée. *Recueil Travaux Station Marine Endoume*, 31 (47), 137p.

INVENTAIRE DE LA FAUNE ICHTYOLOGIQUE DU SECTEUR ORIENTAL DE LA COTE ALGERIENNE (EL KALA; ANNABA; SKIKDA; JIJEL; BEJAÏA)

Wahid Refes [1]*, Nadia Semahi [1], Mostefa Boulahdid [1] and Jean Pierre Quignard [2]
[1] Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral, 16000, Alger, Algérie - wrefes@hotmail.com
[2] Université Montpellier II des Sciences et Techniques du Languedoc, 34060 Montpellier, France

Abstract
Cet inventaire est une synthèse des travaux antérieurs et des observations originales réalisées sur la faune ichtyologique du secteur oriental de la côte algérienne, il a permis de recenser 302 espèces soit 1 Agnatha, 52 Chondrichthyes et 249 d'Osteichthyes.
Keywords: Algerian Basin, Biodiversity, Fishes

Introduction
Ce travail présente un inventaire exhaustif des poissons signalés dans le secteur oriental de la côte algérienne.
Les résultats présentés sont des observations réalisées régulièrement entre 2000 et 2006 lors de campagnes de pêche et dans les ports de pêche, ainsi que les données bibliographiques de plusieurs travaux [1], [2], [3], [4], [5] et [6].

Résultats et discussion
302 espèces ont été recensées soit 1 Agnatha (1 famille), 52 Chondrichthyes (18 familles) et 249 Osteichthyes (88 familles). Les familles les mieux représentées sont les Rajidae (12 espèces), Serranidae (12 espèces), Sparidae (22 espèces), Labridae (19 espèces), Blenniidae (10 espèces) et Soleidae (11 espèces). Ces 6 familles représentent 28,48 % de la diversité spécifique du secteur oriental de la côte algérienne. Une compilation des données ichtyologiques recueillies sur l'ensemble de la côte algérienne [7] et [8] montre que les espèces signalées dans le secteur oriental de la côte algérienne ne représentent que 71,56 % des 422 espèces signalées sur l'ensemble de la côte algérienne, où les Agnatha, Chondrichthyes et Osteichthyes répertoriés représentent respectivement 50, 66,67 et 47,44 % et 72,81 % des espèces recensées sur l'ensemble de la côte algérienne. **Liste des espèces:** Agnatha : *Petromyzonidae (P. marinus)* – Chondrichthyes : *Hexanchidae (H. griseus); Heptranchidae (H. perlo); Echinorhinidae (E. brucus); Squalidae (C. granulosus, C. uyato, C. coelolepis, D. licha, E. spinax, O. centrina, S. acanthias, S. blainvillei); Rhinobatidae (R. rhinobatos); Rajidae (R. alba, R. asterias, R. batis, R. brachyura, R. circularis, R. clavata, R. fullonica, R. miraletus, R. montagui, R. naevus, R. oxyrinchus, R. radula); Torpedinidae (T. marmorata, T. nobiliana, T. torpedo); Dasyatidae (D. centroura, D. pastinaca, D. violacea, G. altavela); Myliobatidae (M. aquila, P. bovinus); Mobulidae (M. mobular); Squatinidae (S. oculata, S. squatina); Alopiidae (A. vulpinus); Lamnidae (I. oxyrinchus); Scyliorhinidae (G. melastomus, S. canicula, S. stellaris); Triakidae (G. galeus, M. mustelus, M. punctulatus); Carcharhinidae (C. altimus, C. brevipinna, C. brachyurus, C. plumbeus, C. obscurus, Prionace glauca); Sphyrnidae (S. zygaena) ; Chimaeridae (C. monstrosa)* – Osteichthyes : *Anguillidae (A. anguilla); Xenocongridae (C. bicolor); Muraenidae (G. unicolor, M. helena); Nettastomatidae (F. oxyrhyncha, N. melanurum); Congridae (C. conger, G. mystax); Ophichthidae (E. myrus, O. refus, O. serpens); Dysommidae (D. brevirostre); Nemichthyidae (N. scolopaceus); Notacanthidae (N. bonapartei, P. rissoanus); Clupeidae (A. fallax, S. pilchardus, S. aurita, S. maderensis); Engraulidae (E. encrasicolus); Argentinidae (A. sphyraena, G. leioglossus, N. oblita); Gonostomatidae (M. muelleri); Sternoptychidae (A. hemigymnus); Chauliodontidae (C. sloani); Stomiidae (S. b. boa); Alepocephalidae (A. rostratus); Aulopidae (A. filamentosus); Synodontidae (S. saurus); Chlorophthalmidae (C. agassizii); Paralepididae (N. rissoi, P. c. coregonoides); Myctophidae (B. glaciale, C. maderensis, D. metopoclampus, E. rissoi, L. crocodilus, M. punctatum, N. elongatus, S. veranyi); Lophiidae (L. budegassa, L. piscatorius); Moridae (G. maraldi, M. moro); Gadidae (A megalokynodon, G. a. argenteus, G. mediterraneus, M. poutassou, M. d. macrophthalma, P. blennoides, P. phycis, T. m. capelanus); Merlucciidae (M. merluccius); Ophidiidae (B. robustus, C. laticeps, O. barbatum, O. rochei); Carapidae (C. acus, E. dentatus); Macrouridae (C. mediterranea, C. coelorhynchus, C. guentheri, H. italicus, N. aequalis, N. sclerorhynchus, T. trachyrhynchus); Exocoetidae (C. heterurus, E. volitans); Belonidae (B. b. gracilis); Atherinidae (A. boyeri, A. hepsetus); Trachichthyidae (H. mediterraneus); Zeidae (Z. faber) ; Caproidae (C. aper); Macroramphosidae (M. scolopax); Fistulariidae (F. commersonii); Syngnathidae (H. hippocampus, H. ramulosus, S. abaster, S. acus, S. typhle); Scorpaenidae (H. d. dactylopterus, S. elongata, S. loppei, S. notata, S. porcus, S. scrofa); Triglidae (A. cuculus, A. obscura, E. gurnardus, L. cavillone, L. dieuzeidei, P. cataphractum, T. lucerna, T. lyra); Dactylopteridae (D. volitans); Serranidae (A. anthias, D. labrax, D. punctatus, E. aeneus, E. caninus, E. costae, E. marginatus, M. rubra, P. americanus, S. cabrilla, S. hepatus, S. scriba); Apogonidae (A. imberbis, E. denticulatus, E. telescopus); Pomatomidae (P. saltatrix); Echeneididae (R. remora); Carangidae (C. glaycos, C. crysos, L. amia, S. dumerili, T. ovatus, T. mediterraneus, T. picturatus, T. trachurus); Emmelichthyidae (C. cirrus, S. flexuosa, S. maena, S. smaris); Pomadasyidae (P. incisus); Sparidae (B. boops, D. dentex, D. gibbosus, D. macrophthalmus, D. maroccanus, D. annularis, D. c. cervinus, D. puntazzo, D. s. sargus, D. vulgaris, L. mormyrus, O. melanura, P. acarne, P. b. bellottii, P. bogaraveo, P. erythrinus, P. auriga, P. caeruleostictus, P. pagrus, S. salpa, S. aurata, S. cantharus); Sciaenidae (A. regius, S. umbra, U. canariensis, U. cirrosa, U. ronchus); Mullidae (M. barbatus, M. surmuletus); Pomacentridae (C. chromis); Cepolidae (C. rubescens); Mugilidae (C. labrosus, L. aurata, L. ramada, L. saliens, M. cephalus); Sphyraenidae (S. sphyraena, S. viridensis); Labridae (A. palloni, C. julis, C. rupestris, L. bergylta, L. bimaculatus, L. merula, L. viridis, L. fasciata, S. c. cinereus, S. doderleini, S. mediterraneus, S. melanocercus, S. melops, S. o. ocellatus, S. roissali, S. rostratus, S. tinca, T. pavo, X. novacula); Trachinidae (E. vipera, T. araneus, T. draco); Uranoscopidae (U. scaber); Blenniidae (B. ocellaris, C. galerita, L. nigriceps, L. pavo, L. trigloides, P. gattorugine, P. sanguinolentus, P. tentacularis, P. zvonimiri, S. cristata); Tripterygiidae (T. tripteronotus); Callionymidae (C. lyra, C. maculatus, C. risso, S. phaeton) ; Gobiidae (A. m. mediterranea, D. quadrimaculatus, G. cobitis, G. cruentatus, G. niger jozo, G. paganellus, L. friesii) ; Gempylidae (R. pretiosus); Trichiuridae (L. caudatus); Scombridae (A. rochei, E. alletteratus, S. sarda, S. japonicus, S. scombrus, Thunnus thynnus); Xiphiidae (X. gladius); Centrolophidae (C. niger); Nomeidae (C. gracilis); Stromateidae (S. fiatola); Tetragonuridae (T. cuvieri); Citharidae (C. linguatula); Scophthalmidae (L. boscii, L. whiffiagonis, P. m. maxima, S. rhombus) ; Bothidae (A. imperialis, A. laterna, A. rueppelli, A. thori, B. p. podas); Soleidae (B. profundicola, B. luteum, D. cuneata, M. ocellatus, M. variegatus, M. hispidus, S. impar, S. kleinii, S. lascaris, S. senegalensis, S. vulgaris); Cynoglossidae (S. ligulatus, S. nigrescens); Balistidae (B. carolinensis) ; Tetraodontidae (E. guttiferum); Molidae (M. mola).*

References
1 - Le Danois E., 1924. Recherches sur les fonds chalutables des côtes d'Algérie (Croisière du chalutier « Tanche »). *Mémoire Office Scientifique Technique Pêches Maritimes*, s.s., 3, 75p.
2 - Maurin C., 1968. Ecologie ichtyologique des fonds chalutables atlantiques (de la baie ibéro-marocaine à la Mauritanie) et de la Méditerranée occidentale. *Revue Travaux Institut Pêches Maritimes*, 32(1), 218p.
3 - Derbal F., Kara M.H., 2001. Inventaire des poissons des côtes de l'est algérien. Rapport Commission International Mer Méditerranée, 36 : 258.
4 - Hemida F., Seridji R., Labidi N., Bensaci J., Capapé C., 2002. Records of Carcharhinus spp. (Chondrichthyes: Carcharhinidae) from the Algerian coast (southern Mediterranean). *Acta Adriatica*, 43(2) : 83-92.
5 - Kara M.H., Bourehail N., 2003. Présence du barracuda, *Sphyraena viridis* (Sphyraenidae), sur les côtes de l'est algérien. *Cybium*, 27(1) : 59-60.
6 - Refes W., Semahi N., Boulahdid M., Quignard J.P., 2007. Diversité des poissons osseux des fonds chalutables du secteur oriental de la côte algérienne. *Pelagos, s.s.*, Workshop international sur la gestion des ressources halieutiques : 41-52.
7 - Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J., Tortonese E., 1984-1986. Fishes of the northeastern Atlantic and the Mediterranean. UNESCO (Paris), vol. 1 (1984), vol. 2-3 (1986), 1473p.
8 - Golani D., Orsi-Relini L., Massuti E., Quignard J.P.,2002. CIESM Atlas of exotic species in the Mediterranean. 1. Fishes. CIESM Publishers (Monaco), 254p.

SPAWNING FREQUENCY OF PICAREL *SPICARA SMARIS* (L.) IN THE SARONIKOS GULF (GREECE)

Constantina Karlou Riga [1]* and Dimitra Petza [2]
[1] FAO, Eastmed Project - constakarlou@gmail.com
[2] Ministry of Rural Development and Food, Directorate of Agricultural Operations and Research, Local Centre of Agricultural Development

Abstract
Monthly sampling of picarel, *Spicara smaris*, was carried out from January to May 2003 in the Saronikos Gulf (Greece).The spawningfrequency was estimated at the peak of spawning (April-May 2003) by the use of post-ovulatory follicles, migratory-nucleus stage and hydrated oocytes. The percentage of the daily spawning females was found equal to 67.74%, which means that the female spawns every 1.48 days on average. Big females, which were predominant during the whole period except of May, accelerated their spawning rate in April forecasting thus the cessation of their spawning season.
Keywords: Aegean Sea, Spawning, Fishes, Demersal

Introduction In the Eastern Mediterranean, picarel (*Spicara smaris* L.) is a commercial and popular species [1]. About half of total landings of this species catch is taken by beach seines, while the other half is distributed between trawlers and nets. Picarel is a multiple spawner [2] with a peak of spawning in the Saronikos Gulf in April-May [3]. In the present study the spawning frequency of picarel was estimated at the peak of spawning in the Saronikos Gulf (Aegean Sea, Greece). This indicator is an important reproductive variable and a crucial parameter for the spawning biomass estimation of the pelagic species [4].

Tab. 1. Spawning frequency of picarel *Spicara smaris* from at the peak of spawning in the Saronikos Gulf (Greece)

	Spawning on the night of capture				Spawned the night before the capture		Mature females
	N			%	N	%	N
Sampling Date	New pofs (<24 h old)	Late MN stage oocytes	Hydrated oocytes		Pof 1 day old		
April 15	5	16	0	44.68	13	27.66	47
April 29	24	28	2	84.38	56	87.50	64
May 13	18	55	8	90.00	65	72.22	90
Total	47	99	10		134		201
Mean %				73.02		62.46	

>

Material and Methods Samples of picarel were monthly (Jan-May 2003) collected by beach seiners, trawlers and gillnets. Specimens were randomly taken from the catch, measured (total length) to the nearest mm, sexed and females were classified to reproductive stages according to Nikolsky's [5] scale. A total of 201 mature ovaries (greater than stage II) out of 419 females, were sectioned. The spawning frequency was estimated at the peak of spawning [4] and was based on the incidence of post-ovulatory follicles (pofs), migratory-nucleus (MN) stage oocytes and hydrated (H) oocytes [6]. The best indicator of the time of spawning may be the occurrence of females with both H oocytes and new pofs [7], because these females have been caught while spawning. In our case H oocytes although with no follicle along with new pofs were indeed found in the samples during night (caught by trawlers or nets). Since the MN stage lasts in a number of species for about 24 h [6], it was assumed that females, which contained late MN stage oocytes or H oocytes (still within their follicles) would spawn on the night of capture, while those females, which contained new pofs had already spawned at the same night. The use of post-ovulatory follicle method [6] can be applied when the age of pofs (based on the extent of their deterioration) is known. Pofs resembling to collapsed structures with however identifiable thecal and granulosa layers (old pofs) indicate that an individual female had spawned 24 h before sampling (pof 1 day), while bigger and very convoluted pofs with linearly arranged granulosa cells (new pofs) indicate that spawning has taken place at the night of sampling (pof < 24 h) [8]. The histological characteristics that were identified in the sections and were used for the estimation of the time of spawning were: late MN stage oocytes or H oocytes or new pofs indicated spawning on the night of capture, while pofs 1 day old indicated spawning occurred the night before capture. Analysis of variance (ANOVA) was performed for the comparison of means.

Results and Discussion During night samplings of picarel, the occurrence of both H oocytes without follicles and new pofs in the ovaries indicated that spawning was indeed in progress at that particular night [6]. Spawning during night is a reproductive strategy for achieving better survival since it provides protection from predators [9]. The histological characteristics which were used to assign the females spawning at the night of capture (i.e. late MN stage oocytes, H oocytes within their follicles, or new pofs) could have never been observed in any possible combination in the ovary of a femaly spawning at the night of capture. The fact that during night samplings late MN nucleus stage oocytes, hydrated oocytes or new pofs were never met in the same ovary indicates the validity of the methodology followed. The percentage of females spawning on one of the two different nights (the night of capture and/or the night before) per sampling date are presented in Table I. It was found that 73.02% of the mature females spawned on the night of capture, while 62.46% spawned the night before. Variance of the monthly percentages was found to be homogeneous for the two spawning nights ($P>0.05$). Thus, analysis of variance of the percentage of females spawning per day (by month as a covariate) on spawning night indicated that the difference was not significant ($F= 0.21$; $P=0.67$). Subsequently, the mean of the two estimates gives the average percentage of the daily spawning females, which was found equal to 67.74%. This means that the female spawns every 1.48 days on average during the peak of spawning (15 April – 13 May: 28 days). Spawning females in April were significantly bigger in length than those caught in May ($P<0.001$). An increase of the spawning frequency more than two times was observed at the end of April (Table I). It seems that big females, which at that period are dominant, accelerate their spawning rate as they reach the cessation of their spawning season. Indeed in May only small females were left spawning, since picarel migrate immediately after spawning to the feeding grounds [10].

References
1 - FAO/FIDI, 2007., Capture production 2005. FAO Yearbook. Fishery Statistics. Capture Production. Vol. 100/1. Rome, FAO, 539 p.
2 - Karlou-Riga C. and Varkitzi I., 2003. Histology for red mullet and picarel ovaries. *Proceedings of 11th Panehellenic Congress of Ichthyologists*, Preveza, Greece (April 10-13, 2003), pp: 113-116 (In Hellenic with English abstract).
3 - Karlou-Riga C. and Makrakos P., 2001. Comparative study of biological behavior of picarel (*Spicara smaris*) and bogue (*Boops boops*) in two areas of the Aegean Sea. *Proceedings of 10th Panehellenic Congress of Ichthyologists*, Chania, Greece (October 18-20, 2001), pp: 9-12 (In Hellenic with English abstract).
4 - Karlou-Riga C. and Makrakos P., 2001. Comparative study of biological behavior of picarel (*Spicara smaris*) and bogue (*Boops boops*) in two areas of the Aegean Sea. *Proceedings of 10th Panehellenic Congress of Ichthyologists*, Chania, Greece (October 18-20, 2001), pp: 9-12 (In Hellenic with English abstract).
5 - Nikolsky G.V., 1963. The ecology of fishes. London and New York: Academic Press, 352p.
6 - Hunter, J. R. and Macewicz, B. J., 1985. Measurement of spawning frequency in multiple spawning fishes. *In:* Lasker R. (ed.), An egg production method for estimating spawning biomass of pelagic fish: Application to the northern anchovy, *Engraulis mordax*. NOAA Tech. Rep. NMFS 36. pp. 79-94.
7 - Hunter, J. R. and Macewicz, B. J., 1980. Sexual maturity, batch fecundity and temporal pattern of spawning for the northern anchovy, *Engraulis mordax*, during the 1979 spawning season. *Calif. Coop. Oceanic Fish. Invest. Rep.* 21: 139-149.
8 - McBride, R. S. and Thurman, P. E., 2003. Reproductive biology of *Hemiramphus brasiliensis* and *H. balao* (Hemiramphidae): Maturation, Spawning Frequency, and Fecundity. *Biol. Bull.* 204:57-67.
9 - Motos, L., 1996. Reproductive biology and fecundity of the Bay of Biscay anchovy population (*Engraulis encrasicolus* L.) *Sci. Mar 60* (2): 195-207.
10 - Harmelin, J.-G., Harmelin-Vivien, M.-L., 1976. Observations « in situ » des aires de ponte de *Spicara smaris* (L) (Pisces, Perciformes, Centracanthidae) dans les eaux de Port-Cros. *Trav. Sci. Parc Natl. Port-Cros* 2: 115-120.

FEEDING SELECTIVITY OF SOME BENTHIC FISH FROM THE ROCKY BOTTOM OF THE ROMANIAN BLACK SEA COAST (AGIGEA AREA)

Irina Rosca [1]*, Aliona Novac [1] and Victor Surugiu [1]
[1] Universitatea Alexandru Ioan Cuza Iasi - ada_iri@yahoo.com

Abstract
Three benthic dominant fish species were analyzed in the Agigea area of the Romanian Black Sea in order to quantify any forage selectivity or avoidance behavior of these fish. For this purpose items found in the stomachs of these fish were identified and compared, in terms of percent occurrence, to the corresponding values of the same species from random rocky bottom transects taken at the point of capture. The calculation of Ivlev's index indicated that amphipods and decapods were positively selected by the analyzed fish. Contrary to the literature sources, the data obtained assign the analyzed fish species to selective predators.
Keywords: Black Sea, Rocky Shores, Fish Behaviour, Zoobenthos

Introduction
The round goby (*Neogobius melanostomus* Pallas 1814), the knout goby (*Mesogobius batrachocephalus* Pallas 1814), and the black scorpionfish (*Scorpaena porcus* Linnaeus 1758) are one of the main benthic feeders from the rocky seabed of the Black Sea. These species are considered to exhibit a generalistic feeding strategy with a relative broad niche width [1]. The aim of this project is to provide qualitative and quantitative data on feeding ecology of these fish species with special emphasis on their feeding selectivity.

Material and Methods
Fish were sampled with a trap net placed at a depth of 9.5 m and 12.5 m. For each species, 100 individuals were dissected and the gastrointestinal tracks were drawn and immediately preserved in absolute ethyl alcohol. The prey items were identified to the lowest taxonomic level as possible. The prey size also was taken into account [2]. In parallel, the macrofauna inhabiting rocky bottom, sampled using SCUBA diving from 0 to 16 m depth, was analyzed in order the establish community structure patterns in terms of species richness, abundance and biomass. Dietary preferences were calculated using Ivlev's selectivity index [3]. The values of 1 indicate the maximum preferences and selectivity towards a food item, those of −1 indicate the maximum avoidance, and 0 indicate the random feeding. Categories in the collected benthos were defined to correspond with the taxonomic levels identified in the guts.

Results and Discussion
The faunistic analysis of the 52 samples from the rocky bottom revealed the presence of 97 taxa, from which 88 were identified to the species level. Dominant groups as number of species were Polychaeta, Amphipoda, Hydrozoa, Decapoda and Turbellaria, which accounted for more than 50% of the total number of the species identified. The diet of analyzed fishes was based on gastropods, amfipods, bivalves, ispods and chironomid larvae. The round goby and the knout goby fed on 35% of the resources of the rocky benthos and the black scorpionfish on 29% of it.

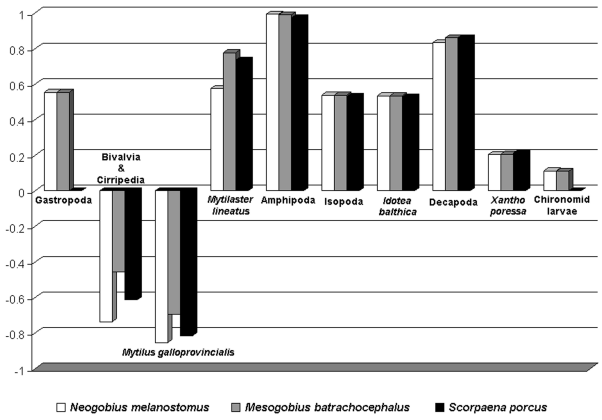


Fig. 1. Ivlev's selectivity index values for *Neogobius melanostomus*, *Mesogobius batrachocephalus* and *Scorpaena porcus*

The Ivlev's index indicated that the food items positively selected by the fish were mainly amphipods (>0.90)and decapods (>0.58)(Fig. 1). From the bivalves only *Mytilaster lineatus* showed positive selection. Although the benthic samples revealed that *Mytilus galloprovincialis* is the dominant species, it presented negative electivity values for all the three species of fish analyzed (−0.85 for round goby, −0.69 for knout goby and −0.81 for black scorpionfish). The avoidance of this species may be due to either digestibility or their body size. Comparing the content of the fish guts with the macrozoobenthos from different depths, it has been observed that there are small differences, except those related to the bivalves *Mytilus galloprovincialis* and *Mytilaster lineatus*. The round goby and the knout gobyseem to avoid *Mytilaster* between 0 and 2 m depth (−0.455 and −0.001 respectively), but prefer it at greater depth (0.893 and 0.958 respectively). It is difficult to determine why a particular prey type is selected. We suggest that several of the important factors are prey size, mobility, type of fixing to substratum, activity and digestibility. Based on the obtained data it can be concluded that these fish species are selective feeders.

Acknowledgements : This work has been financially supported by the National Authority for Scientific Research (Grant PN-II-ID No. 116 and BD No. 320).

References
1 - Banarescu P.,1964. Fauna Republicii Socialiste Romania. Pisces-Osteichthyes. Ed. Acad. R.S.R., Bucuresti, pp 832-836, 853-855, 867-872.
2 - Grabowska J., Grabowski M.,Pietraszewski D. and Gmur J., 2009. Non-selective predator - the versatile diet of Amur sleeper (*Perccottus glenii* Dybowski, 1877) in the Vistula River (Poland), a newly invaded ecosystem. *J.Appl.Ichthyol*., 25: 451-459.
3 - Gomoiu M.-T. and Skolka, M., 2001. Ecologie, metodologie pentru studii ecologice. Ovidius University Press, Constanta, pp147-150.

GROUP DYNAMICS OF BOTTLENOSE DOLPHINS ENGAGING IN GILL-NET FEEDING ACTIVITIES IN THE BOCCHE DI BONIFACIO INTERNATIONAL MARINE PARK (ITALY-FRANCE)

A. Rotta [1], A. Pira [1], A. Floris [2], M. Piras [3], M. G. Pennino [3]*, G. G. Leoni [4], M. Ugo [5], J. M. Culioli [6], N. Negre [6], F. Berlinguer [1] and S. Naitana [1]

[1] Dipartimento di Biologia Animale, Sezione di Fisiologia, Facoltà di Medicina Veterinaria, Università degli Studi di Sassari.
[2] Parco nazionale dell'Arcipelago di la Maddalena
[3] Dipartimento per l'ambiente, Centro Turistico Studentesco. - graziapennino@yahoo.it
[4] Servizi Generali, Facoltà di Medicina Veterinaria, Università degli Studi di Sassari.
[5] Dipartimento di Scienze Fisiologiche, Biochimiche e Cellulari, Facoltà di Medicina Veterinaria, Università degli Studi di Sassari
[6] Office de l'Environnement de la Corse. France

Abstract

Foraging specializations among marine mammals are susceptible to social transmission and could lead to the separation of distinct social units, thus increasing conservation challenges. We analysed the association patterns of the bottlenose dolphins population of the Bocche di Bonifacio International Marine Park to verify the existence of two distinct communities based on different feeding strategies. No correlation was found between the dolphin foraging tactics and community membership. Moreover, the population seems to be ruled by a random association strategy. For these reasons the managing authorities should treat this population as one entity and take effective synergic actions to ensure the conservation of this resource and its habitat.

Keywords: Cetacea, Marine Parks

Introduction

Culturally differentiated communities among marine mammals populations are widely documented [1]. The transmission of cultural traits, such as peculiar foraging tactics, to preferred associates can trigger the development of behaviourally differentiated units belonging to the same population [2,3]. Bottlenose dolphins inhabiting the waters of the 'Bocche di Bonifacio' International Marine Park regularly interact with the trammel nets set by the coastal fisheries operating in this area. The purpose of this paper is to describe the patterns of associations of this bottlenose dolphins population and investigate whether the net-foraging behaviour is a cultural trait which influences the dolphin social structure distinguishing a community from another within the population.

Material and Method

From July 2006 to July 2008, 139 boat-based surveys, leading to 112 dolphin sightings, were made in the study area (408 km^2). During each encounter date, sex and behaviour were recorded and 71 individuals were photo-identified and catalogued. Dolphins were categorized as 'trammel-feeders' (Tf) or 'non-trammel-feeders' (Ntf) based on whether they had ever been observed foraging on gillnets [4]. Association analysis were carried out on 23 animals sighted at least 5 times using the Half Weight Index of association [5] in Socprog 2.3. Firstly, the degree of social interaction between dolphins with different feeding habits was assessed. Secondly, the null hypothesis that individuals associate randomly was tested for the whole population and separately for each dyad.

Results and Discussion

Although within-classes associations (Tf-Tf = 0.13; Ntf-Ntf = 0.25) were higher than between-classes (Tf-Ntf = 0.06), the differences were not significant (t= 6.20, p=1, correlation coefficient= 0.38), highlighting that individuals significantly and frequently interact also with animals that have different foraging tactics. No evidence of significantly high associations coefficients was detected, since the standard deviations for both observed and randomly permuted HWI means had very similar values (P > 0.5). Furthermore, only one dyad showed a significant level of association (P > 97.5), a value even lower than that expected if associations were completely random. In conclusion, the foraging specialization detected in the population cannot demonstrate the existence of culturally separated communities based on social learning of different feeding strategies. For these reasons the Bocche di Bonifacio dolphin society should be considered as one entity. Furthermore, since no significantly high or small associations indexes were detected either at population or at dyadic level, it can be inferred that this community lives in a fission-fusion society where companions are likely to be chosen randomly. These results represent important findings that the managing authorities of the Bocche di Bonifacio international Marina Park, namely the "Arcipelago of La Maddalena" National Park and the "Bocche di Bonifacio" Natural Reserve, should consider as fundamental assumptions when addressing the conservation issue of this biological resource.

References

1 - Whitehead H, Rendell L, Osborne RW, Würsig B., 2004. Culture and conservation of non-humans with reference to whales and dolphins: review and new directions. Biological Conservation Vol. 120:427-437.

2 - Chilvers BL, Corkeron PJ., 2001. Trawling and bottlenose dolphin social structure. Proceedings of the Royal Society of London B268: 1901–1905.

3 - Krützen M, Mann J, Heithaus MR, Connor RC, Bejder L, Sherwin WB., 2005. Cultural transmission of tool use in bottlenose dolphins. *Proc. Natl. Acad. Sci*. U.S.A. 102: 8939–8943.

4 - Chilvers BL, Corkeron PJ., 2002. Association patters of bottlenose dolphins (*Tursiops aduncus*) off Point Lookout, Queensland, Australia. *Canadian Journal of Zoology*, 80: 979-979.

5 - Cairns JS, Schwager SJ., 1987. A comparison of association indices. *Animal Behaviour*, 35: 1454–1469.

ON THE TERMAL CONTROL OF *COTYLORHIZA TUBERCULATA* JELLYFISH POPULATION

Javier Ruiz [1]*, Diana Astorga [1] and Laura Prieto [1]
[1] Department of Coastal Ecology and Management, Instituto de Ciencias Marinas de Andalcía (CSIC) - javier.ruiz@icman.csic.es

Abstract
Cotylorhiza tuberculata is a jellyfish generating outbursts in the coastal lagoon of Mar Menor since mid-90s. Ups and down of the population proceeded along different years without a clear scientific understanding of its origin. In this manuscript we hypothesize that the tight control exerted by temperature on the life cycle of *Cotylorhiza tuberculata* is the origin of such fluctuations. Temperature triggers the strobilation process and cold waters generate high mortalities to the benthic phase. Modelling this thermal control results in simulations of medusa stocks closely resembling its weekly landings in the coastal lagoon. Conclusions derived from this closed population are a fore-signal of future evolution of jelly fish species in a Mediterranean with milder winters an longer summers.
Keywords: Medusae, Models, Coastal Processes

The Mar Menor is a large (135 Km^2) and shallow (3.5 m average depth) lagoon almost isolated from the western Mediterranean by a 22 Km long sandy bar. Progressive increase of both human pressure on the shores and agriculture forcing on the draining waters modified original communities during the 80s [1]. Parallel to this degradation, and coherently with an habitat-deterioration triggering of jellyfish blooms [2], *Cotylorhiza tuberculata* (CT) first appeared in the lagoon and started to build massive outbreaks in early 90s [3]. Highs and lows of CT abundance in the Mar Menor progressed since its first appearance without scientific understanding of the fluctuation origin. The societal alarm and the economic impact on bathing activities activated a program to extract medusa from the lagoon and generated a time series of capture per unit effort data.

A Bayesian model was implemented to assimilate these data in the mechanics driving the life cycle of exploited populations [4], The model tested the hypothesis that fluctuations have their origin in the tight control that temperature exerts on the life cycle of CT. Based on controlled experiments, all phases of the life cycle except strobilation and polyp mortality were found insensitive to the range of physical conditions present in the lagoon. Strobilation is triggered when the water temperature first rises over ~18ºC with negligible ephira production later on. Therefore, the summer spam for the medusa phase can be accounted in terms of the time the lagoon is >18ºC. Longer summers imply longer periods for medusa somatic growth and for population biomass to accumulate. Owing to the annual life-span of CT, polyps are responsible to transfer the population across winters but their survival is very sensitive to cold waters. Temperatures bellow 16ºC result in mortalities that, when accumulated along the winter, heavily impact the remnants individuals available for strobilation and medusa generation in the subsequent summer. The model is then articulated on the basis of successive stages of polyp and medusa that alternate under the control of lagoon temperature and the progress of seasonal cycles. The simulated medusa stock in the lagoon reproduces an intra and inter-annual evolution coherent with the observed abundances of CT. This includes the massive outbursts during the long summers from 2000 to 2004 as well as the dramatic collapse of medusa population in 2005, after a previous very severe winter. The capacity of a thermally-forced life-cycle to explain *in situ* changes indicates the severe control that temperature exerts on CT abundance. Once the ecosystem-degradation conditions for jellyfish outbreaks are met, and the homeostasis of the system decreased, CT seems to fluctuate under the simple rule of the warmer the better.

Though the link between environment and scyphozoa populations has been extensively explored before (e. g. [5]) they mainly investigate statistical correlations between environmental indexes and jellyfish abundance rather than identifying the cause-effect control in the mechanics of jellyfish life-cycle and population dynamics. This mechanics offers a more solid ground to understand past periods of jellyfish occurrence and to project future expectations in a Mediterranean where milder winters and longer summer will modify the community balance of winners and losers.

References

1 - Pérez-Ruzafa, A., Gilabert, J., Gutiérrez, J.M., Fernández, A. I., Marcos, C. and Sabah, S., 2002. Evidence of a planktonic food web response to changes in nutrient input dynamics in the Mar Menor coastal lagoon, Spain. *Hydrobiologia*, 475/476: 359–369.
2 - Richardson, A. J., Bakun, A., Hays, G. C. and Gibbons, M. J., 2009. The jellyfish joyride: causes, consequences and management responses to a more gelatinous future. *Trends in Ecology and Evolution*, 24 (6): 312-322.
3 - Francesc Pagès, 2001. Past and present anthropogenic factors promoting the invasion, colonization and dominance by jellyfish of a Spanish coastal lagoon. CIESM Workshop Series nº 14. Gelatinous zooplankton outbreaks: theory and practice: 69-71.
4 - Ruiz, J., R. González-Quirós, L. Prieto and G. Navarro., 2009. A Bayesian model for anchovy: the combined pressure of man and environment. *Fisheries Oceanography*. 18(1): 62–76.
5 - Attrill, M.J., Wright, J. and Edwards, M., 2007. Climate-related increases in jellyfish frequency suggest a more gelatinous future for the North Sea. *Limnology and Oceanography* 52, 480–485.

SIX YEARS OF SURVEY (2004-2009) ON REPRODUCTION OF SEA TURTLES ON SHKAÏFATE BEACH, SYRIAN COAST (PROPOSED AS PROTECTED AREA)

A. Saad [1]*, A. Rees [2], W. Sabour [3], A. Othman [3], C. Genaidi [3] and N. Alkhateeb [3]
[1] Tishreen University, Lattakia, Syria - adibsaad@scs-net.org
[2] Sea Turtle Prtoction Society of Greesce
[3] Syrian Society for Aquatic Environment Protection, Lattakia, SYRIA

Abstract

Nesting turtles survey between 2004 – 2009 were conducted along the coast between Shkaifat and Snawbar (south of Lattakia city), along a 12.5 km stretch of coast. Results from the 2004- 2009 nesting season confirmed that a skaifat- snawbar beach near Latakia in Syria was an important nesting site for green turtles in the Mediterranean

Keywords: Beach, Conservation, Turtles, Levantine Basin, Monitoring

Introduction

The presence of loggerhead and green sea turtles(*Chelonia mydas*) and loggerheadturtle **(***Caretta caretta*), off the coast of Syria, was first reported by Gruvel [1], but nesting on the country's beaches was not indicated. The next turtle information to come out of Syria resulted from a rapid assessment survey in 1991 that identified low-level nesting concentrated on a beach south of Latakia City [2]. Local researchers noted incidental turtle captures in beach seines, and also observed turtles stranded along the coast [3]). Since 2004 a more extensive coastal survey was undertaken, primarily to better identify Syria's actual and potential nesting populations [4] .

Martial and Methods

From last week of may to second week of October the 7.5 km beach between North Jableh and Snowbar, 35°28'00"N, 35°51'45"E was surveyed in the earl morning for evidence of sea turtle nesting, nest hatching and events that may have affected the incubation of nests, such as inundation by storm waves or depredation. The adjoining beach to the north, from Snowbar to the river Al Kabir Ash Shamali next to Lattakia, 5 km to the north, was surveyed, as a continuation of the daily survey, 10 times at weekly intervals to record the same information.

Emergence tracks from adult turtles were checked for species and evidence of nesting and the track recorded as either a nesting or non-nesting emergence... Nesting species was determined by appearance of the track [5] and by maximum width of the track . In the eastern Mediterranean, loggerhead turtles are generally far smaller than green turtles , and hence their track widths are generally much narrower. Additionally nest excavation often afforded confirmation of species by identification of dead or live hatchlings or embryos . For determining the movement of sea turtles during and after the reproduction period, we tagged 64 individual during 2004- 2009 by metal tags contain the name and address of the teem leader.

Results and Discussion

During 2004, 2006, 2008 and 2009 we noticed 8, 15 and 21 nests in each kilometer (respectively) for the green turtle *Chelonia mydas*, as for *Caretta caretta*, we recorded many nests and spawning sites in the same beach, but in less number (Fig 1). During 2005 and 2007, the number of nest very lower (3 and 2 nest per km of the beach). These results indicate that this surveyed area is among the best sixth coastal zones suitable for the reproduction of the green sea turtles all round the Mediterranean coast. Syria may also play a significant role hosting foraging turtles, asloggerheads from both

Cyprus and Greece have been shown to forage in near shore Syrian waters [6]. Since green turtle *Chelonian mydas* nesting was discovered in 2004, repeated surveys have indicated that Latakia beach hosts a regionally important rookery. This, together with the presence of lower frequency nesting at a few other beaches places Syria as the third most important country, after Turkey and Cyprus, for green turtle nesting in the Mediterranean. Gerosa and Casale [7] indicate that interaction of sea turtles with fisheries in the Mediterranean is a major threat and that little is known of the level of incidental turtle captures in Syria. Since 2007. We undertaken a field work concerning this problem.

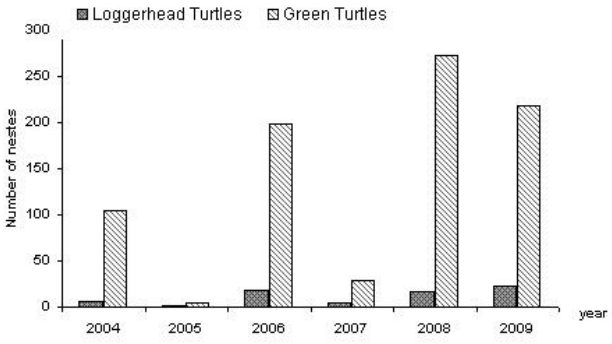


Fig. 1. Variation of the number of nest turtles : loggerhead and green) on Lattakia beach during six years of survey

References

1 - Gruvel A.1931. Les Etats de SAyrie. Richesses marines et fluviales.Exploitation actuelle-Avenir. Biblioteque de la faune des colonies Francaises III.Paris, societe d'Editions Geographiques, Maritimes et Coloniales.

2 - Kasparek M. 1995. The Nesting of Marine Turtles on the coast of Syria. Zoology in the Middle East 11, 51-62

3 - SAAD A., REES .A., 2004. Status of Marine turtles in Syria 2004: Focus on nesting beach investigation (Case study and recommendation for future research). Proceeding of the workshop INOC Meknas , Marroco, 2-5 November 2004

4 - Rees AF, A Saad & M Jony. 2008. Discovery of a regionally important green turtle *Chelonia mydas* rookery in Syria. Oryx 42(3): 456-459

5 - SCHROEDER, B. & MURPHY, S. 1999. Population surveys (ground and aerial) on nesting beaches. In Research and Management Techniques for the Conservation of Sea Turtles (eds K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois & M. Donnelly), pp. 45–55

IMPACT OF INVASIVE SPECIES ON THE BIODIVERSITY AND FISH STOCK; CASE STUDY: *FISTULARIA COMMERSONII* RUPPEL, IN THE SYRIAN COAST

Adib Ali Saad [1]* and Waad Georges Sabour [1]
[1] Tishreen University- Lattakia, SYRIA - adibsaad@scs-net.org

Abstract
Reproductive cycle and feeding habit of bluespotted cornet fish *Fistularia Commersonii*, new lessepsian migrant was studied in the Syrian coastal water (Levantine Basin). *Fistularia commersonii* recorded for the first time in this area during 2001 has shown a rapid development among the ichtyofauna in the Eastern Mediterranean. It is carnivorous, and feed on many small fish species, such as *Sardinella* spp., *Sprarus spratus*, *Alosa fallax*, *Boops bops* .etc. 12-30 individual preys was found in the stomach of every specimen. The high fecundity rate, the long period of reproduction, (May–August) and its rapidly expanding population feeding on fish, make a decline of the biomass and causing damage and loss to fisheries yield.
Keywords: Life Cycles, Migration, Biodiversity, Fishes, Levantine Basin

Introduction
During the nineties, a strange fish species of Indo-Pacific origin from family Fistularidae (cornetfishes) appears in the south-east Levantine Basin, the first record was reported by in the Palestinian coastal [1]. In July 2001 three specimens of *Fistularia commersonii* of total length (ST): 35.6; 77.8; 82.3 cm (SL) respectively was caught with beach seine in the seawater south Lattakia (35.44' N; 35.89' E) at a depth of 12 m. It was the first record of this lessepsian specis in the Syrian waters [2]. It was also reported in adjacent Lebanese coastal waters [3]. Two years later, it was observed with great number and became strong invader with regard to the increased percentage in the catch. Given the environmental conditions changes occurring in the Mediterranean and because of the connection between the Levantine Basin and the Red Sea through the Suez Canal, the East Mediterranean was subject to a big invasion of marine species. In the beginning this invasion was very slow because of the big difference in salinity between the both marine environments and because the high salinity of Bitter lake which constituted a natural barrier to the migration of marine organisms. Prior the construction of Aswan High Dam, the freshwater of the Nile during the flood, in reducing the salinity at the entrance Nord of the canal at Port Saïd, contribute to constitute a hypo-saline seawater forming a barrier to this migration. After the functioning of the High Dam in 1965 and the stop of the flood, the salinity of the south-east corner of Mediterranean start increasing , making little difference in the salinity between the Red sea and East Mediterranean. The increased navigation through the Canal pathway during the last century and the global warming occurring word wide in the oceans inducing the rise of the Mediterranean water salinity have enhanced the Lessepsian migration process. The number of invasive fish species in the Levantine Basin reach to date 65 [4,5] , from which 43 are recorded in the Syrian waters. [6] Fistularia commersonii is themore recent newcomer fish record in our water [2], measuring a total length of 29 cm. Afterwards the caught number by fish training nets increased progressively. In May 2003, 36 individuals measuring between 40 and 108 cm were caught in only one fish net. After this period, we observed increasing frequency of this invading species in the fishermen nets and with high number forming about 2-3% of the total net coastal catch. Given that the introduction of new species in the environment can surely affect in the marine biodiversity and in the competition of the biocoenoses and food, it is very important to know the behavior of reproduction and feeding of the newcomers in the local ecosystem in order to know it stock management and understand the relationship between themselves and between them and native species and thus knowing its role in the structure of the biodiversity in this ecosystem.

Material and methods
The study was performed in the coastal area of Lattakia along 80 km between Turkish border in the north and Banias in the south. A total of 460 specimens of Bluespotted cornet fish *Fistularia commersonii* were collected by beach seine and trammel net at depth of 2-20 m from August 2004 to September 2005. For each fish, the total length (TL) and standard length (SL) were measured to the nearest centimeter and total weight (W) to the 0.1 g. Sex and maturity were determined macroscopically. The weight of the gonad (Wg) was recorded to the 0.01 g. Spawning season was determined in using the monthly change of stages of maturation and the gonado-somatic index (GSI). Fecundity was estimated gravimetrically. In addition, the feeding habit was studied by analysis of food content in the digestive tube.

Result and Discussion
The GSI values of females were generally higher than those of males, but both indices followed the same pattern. According to the examination of maturation stages and GSI values, *Fistularia commersonii* spawned in the Syrian coast from the second half of May until early August, with greatest intensity in June (Fig.1). The first sexual maturity of *F. commersonii* shows that 50% of females and males are sexually mature at standard length of 57.5 and 56 cm respectively . Males matured at smaller length intervals than females. Fecundity ranged between 355-697 eggs/g /ovary. This high fecundity rate contributes to increase the recruitment and juvenile population invade new ecological niches at the expense of native fish species. Certain negative impact on local fish stock through predation and feeding on small fishes was noticed (Fig.2). In studying the feeding regime and the dynamics of the reproduction, we conclude that *Fistularia* is a carnivorous predator feeding quasi exclusively on local fish, namely *Sardinella aurita*, *Boops boops* and *Engraulis encrasicolus.* The stomach content analysis has shown 20-25 fish individuals in one digestive. This may give an idea of the strong negative effect of thousands of Fistularia individuals on local living fish stock.

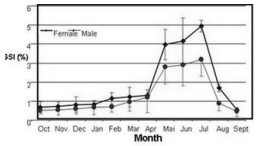


Fig. 1. Evolution of gonado-somatic index (GSI) of F.Commersonii



Fig. 2. Composition of fish preys in the stomach content of *F.Commersonii*

References
1 - Golani D., 2000, "First record of the blue spotted cornet fish from the Mediterranean sea" *Journal of Fish Biology*, 56: 1545-1547.
2 - Saad, A., 2002. "Characterization of Lessepsian migrant fish at Syrian sea waters (Eastern Med.)", *Proceeding of the International Workshop on "Mediterranean Vermitid Terraces and Migratory Invasive organisms*" INOC/CNRSL, Beirut/Lebanon, 19-22 December 2002.
3 - Lakkis, S., 2009. "Biological Invasion in the East Mediterranean, Is it a sequence of "Tropicalization" and Global Worming? Case study: Exotic Marine Species in Lebanese Seawaters", *3rd GLOBEC Open Science Meetings, Victoria, B. C. Canada*, 22-26 June, 2009:135.
4 - Golani, D., L.Orsi-Relini, E., Massuti and J. P. Quignard., 2002. "*CIESM Atlas of Exotic Species in the Mediterranean, Vol. 1. Fishes*, [F. Briand Ed.], p. 256, CIESM Publishers, Monaco.
5 - Golani, D., L.Orsi-Relini, E., Massuti and J. P. Quignard, J**.** Dulcic , and E. Azzurro., 2009. Apdate of Fishes *Atlas of Exotic Species in the Mediterranean*, in : http://www.ciesm.org/atlas/appendix1.html.
6 - Saad, A., 2005. "Cheek-List of marine bony fish in Syria", *Turkish Journal of fisheries and Aquatic science*, Vol.5,no.2: 99-106.

GEOGRAPHICAL AND BATHYMETRICAL DISTRIBUTION OF RED SHRIMPS IN SARDINIAN WATERS RELATED TO ENVIRONMENTAL CONDITIONS

Andrea Sabatini [1]*, Gloria Matta [1], Francesco Palmas [1] and Antonio angelo Pendugiu [1]
[1] Department of Animal Biology and Ecology, University Of Cagliari - asabati@unica.it

Abstract
Red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus* are one of the most important and exploited resource in the western Mediterranean. The aim of this work is to evaluate the geographical and bathymetrical distribution of the two species in Sardinian seas and to identify a possible relationship with environmental conditions. We calculated the ratio between the two species and we compared ratio values with hydrological data (temperature and salinity) to establish how water masses properties influence species distribution. Our results indicate that *A. antennatus* prefers colder and less salty waters while *A. foliacea* prefers both higher temperature and salinity.
Keywords: Crustacea, Intermediate Waters, Western Mediterranean

Introduction
Red shrimps are mainly captured at depths between 400 and 800 m while unexploited below 900 m. In Sardinian waters we can find both species: in the southern and eastern parts *A. foliacea* is more abundant, while *A. antennatus* is more present along the northern and western coasts [1]. The spatial and temporal variability of these two species seems to be closely connected to hydrological and oceanographic factors and the distribution of red shrimps may be correlated to water mass properties such as salinity and temperature.

Materials and Methods
The biological data were collected in Sardinian waters between 1994 and 2006 during two annual trawl survey as part of the research projects Medits and Grund. Taking into account the number of individuals of *A. foliacea* (Af) and *A. antennatus* (Aa), logistic models were calculated fitting the ratio between the two species in function of depth:

$$Ratio = Aa/(Aa + Af)$$

Using logistic regressions, depth values for Ratio 0.5 (D_{50}), 0.25 (D_{25}) and 0.75 (D_{75}) respectively were calculated. D_{50} represents the depth in which the two species have the same abundance, D_{25} and D_{75} the depth in which the 25% and the 75% of individuals, respectively, are *A. antennatus*. Hydrographic data were extracted from the MEDATLAS database [2] and a mean value of temperature and salinity was considered. The data were correlated whit the correspondent ratio values for different Sardinian coasts between 400 and 800 m.

Results and Discussion
The logistic models obtained for Sardinian waters showed that in the northern and western Sardinia there is an equal occurrence of the two species at about 453 m and 478 m (D_{50}) respectively indicating a greater presence of *A. antennatus* in the whole depth range analyzed. The southern Sardinia is characterized by an extended presence of *A. foliacea* (D_{50}=612 m) while in the south-eastern Sardinia *A. foliacea* predominates over the whole depth range even below 650 m (D_{25}=647 m) (Fig. 1).

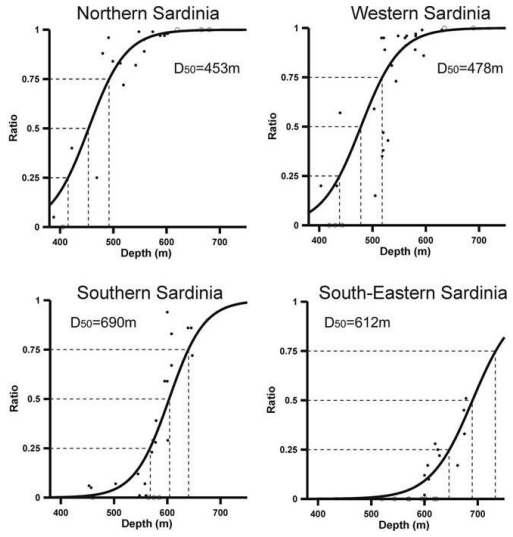


Fig. 1. Logistic models (Ratio values in function of depth)

These results showed that the ratio between the two species is very different among Sardinian coasts. The Regression Analysis, carried out fitting ratio values against hydrographic data, indicated that the ratio between the two species is correlated with environmental conditions (Fig. 2).

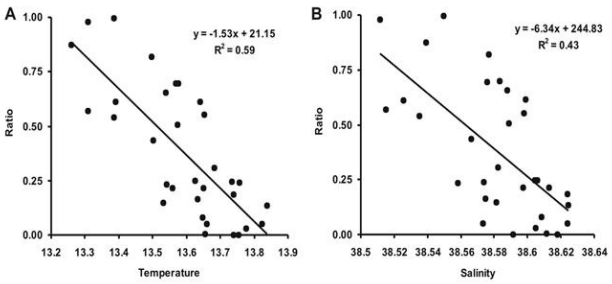


Fig. 2. Regression between Ratio values and (A) temperature and (B) salinity

Our results showed an already known bathymetrical distribution of the two species. The fluctuations in ratio and species distribution seem to be connected to environmental conditions and in particular to the circulation of intermediate water masses along Mediterranean coasts [3]. The comparison between hydrographic and biological data evidenced that both species seem to be connected to the peculiar features and fate of the LIW (Levantine Intermediate Water). In fact, in the eastern and southern part, LIW properties predominate and *A. foliacea* is the main species while in the western and northern sides of Sardinia LIW properties lose intensity in favor of *A. antennatus* which prefers colder temperatures and less salty waters.

References
1 - Cau A., Carbonell A., Follesa M.C., Mannini A., Norrito G., Orsi-Relini L., Politou C.Y., Ragonese S. and Rinelli P., 2002. MEDITS-based information on the deep-water red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus* (Crustacea: Decapoda: Aristeidae). *Sci. Mar.*, 66: 103-124.
2 - Medatlas group, MEDATLAS 2002. Database and climatological atlas of temperature and salinity. Three CD-ROMs and the web site http://www.ifremer.fr/medar/.
3 - Millot C., 1999. Circulation in the Western Mediterranean Sea. *J. Mar. Syst.*, 20: 423-442.

SOME BIOLOGICAL PARAMETERS OF SPRAT *SPRATTUS SPRATTUS PHALERICUS* (RISSO1826) IN THE TURKISH BLACK SEA COAST

Hacer Saglam [1]*, Ertug Duzgunes [1] and Nazli Kasapoglu [1]
[1] Karadeniz Technical University, Faculty of Marine Science - hacersaglam@yahoo.com

Abstract
Some biological parameters of the sprat, *Sprattus sprattus phalericus*, collected from Turkish Black Sea coast between 2008 and 2009 were investigated. Sprat is an important food resource for many top predators. In present work, length frequency distribution, relationship between length and weight, sex ratio and condition factor of sprat have been studied.
Keywords: Black Sea, Biometrics, Pelagic

Introduction
Black Sea sprat, *Sprattus sprattus phalericus*, is one of the most abundant small pelagic fish species in the Black Sea. It is an important food resource for many top predators. The sprat is a small, multiple (batch) spawning species with a protracted spawning season and a large number of spawning per year. According to 2006 fishery statistics, 7311 tons of sprats were harvested in Turkey of which 6681 tons were caught from the Black Sea and 630 tons from the Sea of Marmara [1].

Material and Method
Sprats were caught as by-catch in the purse seine fishery in 2009. The total length (L) and weight (W) were measured and sex was determined by gonads. The total number of investigated individuals was 334. The length-weight relationship was derived as $W=aL^b$, where W: weight (in g); L length (in cm), a: y-intercept and b: slope, characterizing the growth rate. The condition factors (CF) are computed by Fulton's index [2] as
$CF = W*100/L^3$
where W is average weight and L is average length by size groups.

Results and Discussion
The sample was composed of 202 females ranging between 7.20 and 10.2 cm TLand 2.15 and 7.11 g, and 132 males ranging between 6.80 and 10.20 cm TL and1.68 and 6.35 g. The sex ratio was significantly different from 1:1 (χ^2=14.67; df=1; P<0.05). The input data for average lengths and weights of sprat are given in Table 1. According to data in Table 1 and using power function, the coefficients "a" and "b", characterizing weight-length relationship, have been estimated.

Tab. 1. *Sprattus sprattus* and some biological parameters

Parameters	F	M	Total
L±SE	8.74±0.042	8.69±0.053	8.72±0.032
W±SE	3.80±0.060	3.57±0.073	3.69±0.046
$W=aL^b$	$0.0066L^{2.919}$	$0.0065L^{2.911}$	$0.0070L^{2.885}$
r^2	0.87	0.85	0.85
CF (%)	0.518	0.494	0.507
n	202	132	334

Condition factor between differences between females and males was not significant in present study (P>0.05). The length frequencies of sprats are shown in Figure 1. The obtained results are not close to those, calculated by Sahin (1999) [3]. Sahin (1999) reported that the mean length values were 10.69 cm for both sexes in 372 specimens. According to our results, the average sprat length has been lessening in decade.

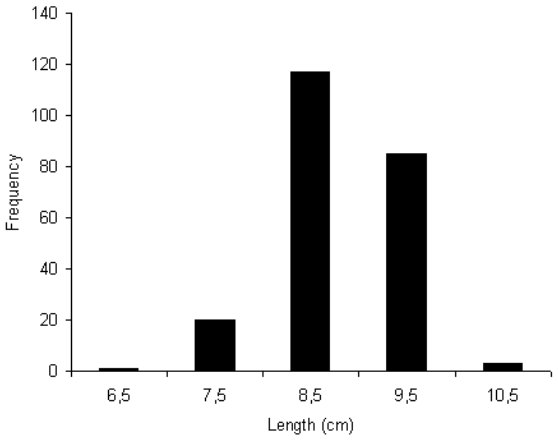


Fig. 1. Length frequency distribution of the sprat caught in the south-eastern Black Sea

References
1 - TUIK., 2006. Fishery Statics, Ankara.
2 - Ricker., 1975. Computation and interpretation of biological statistics of fish populations. *Bull.Fish.Res.Board Can.*, 191:382 pp.
3 - Sahin, T., 1999. Some Biological Characteristics of Sprat (*Sprattus sprattus* phalericus RISSO, 1826) on the Eastern Black Sea Coast, Turk. *J. Zool*., 23: 249-256.

INTERSTITIAL HARPACTICOIDS FROM THE SHALLOW WATERS OF THE ROMANIAN BLACK SEA COAST

Manuela Samargiu [1]*

[1] Ovidius University, Faculty of Natural Sciences and Agricultural Sciences - manuelasamargiu@yahoo.com

Abstract

The study refers to a period of five years and the results regard a synecologic analyze of harpacticoids populations sampled from 11 sites with mobile substratum at 0 – 1 m depth, on a distance of more than 200 km along the Romanian shore, from Grindul Chituc to Vama Veche. Data about their abundance, density, frequency and ecological significance indices (WD %) are given, in order to emphasis the distribution of the characteristic species and their adaptive mechanisms.

Keywords: Black Sea, Copepoda, Infralittoral, Mediolittoral, Sediments

Introduction

For marine waters of Romania, the data obtained between 1960 -1970, totalize 114 benthic harpacticoids species, associated with different characteristic biocoenosis. A first comprehensive list was done in 1959 [1] and after those three ample papers regarding pontic [2, 3] and Levantine [4] harpacticoids were published in 1960, 1962 and 1964. After more than 25 years, some ecological data of main harpacticoids species living on different kind of substrata were published again [5, 6].

Materials and methods

Quantitative sedimentary samples were taken using a corer with 7, 5 cm intern diameter. 11 sites (with three perpendiculars transects at 0, 0, 5 and 1 m depth) were seasonally investigated, during a period of five years. The samples have been preserved (4% formaldehyde solution or in ethanol 80%: glycerin in equal parts), washed and sieved by 160, 100 and 63 μm mesh diameter. A Nikon SMZ-2T stereomicroscope and a Nikon E200 microscope were used for identification. The results were reported at m².

Results and discussions

The most encountered harpacticoids have the greatest abundances in 20 - 50 cm core horizon of the samples. Below this horizon we met extremely rare in corers, isolated examples of *Arenopontia subterranea* and *Parastenocaris chappuisi*. In two stations of the north sector Grindul Chituc (Lat. 44º N 47, 310; Long. 28º E 81,432) and Vadu (Lat. 44º N 35, 240; Long. 28º E 62,212) where sediments are consisting of fine and quartz sands eudominant species are *Microarthridion littorale* and *Canuella perplexa*, with great similarities regarding their abundances (A = 67 ind.·m^{-2}), frequency of 40 % and W = 11%. *Harpacticus flexus* (A = 51 ind.·m^{-2},F = 40 %, W % = 8, 98) and *Halectinosoma abrau* (A = 43 ind.·m^{-2}, F = 40 %, W = 7, 57) have dominant character in these sediments (the highest share at 0.5 m depth). At Navodari (Lat. 44º N 18, 707; Long. 28º E 37,913) and on Mamaia – Cazino (Lat. 44º N 14,297; Long.28º E 37,548) zones, 10 respectively 15 harpacticoids species were recorded with total abundances of 1306 and 580 ind.·m^{-2}. For both zones *M. littorale* is on the first rank with high values of W = 19, 90% and 30%, frequency of 100%, and abundances of 260 and 174 ind.·m^{-2} comparatively with the other species. *Parathalestris dovi* and *Canuella perplexa* are other dominant species. But for all mentioned species densities do not exceed 39 ind.·m^{-2}. Longipedia minor, Tisbe furcata, Ectinosoma melanicepsTabacariei Lake flows into the sea we found occasionally isolated individuals of Itunella muelleri, *Parastenocaris chappuissi* and *Onychocamptus* mohammed. Total density of harpacticoids population recorded 67 ind.·m^{-2}. Constanta – Plaja Modern site (Lat. 44º N 10,718; Long. 28º E 39,452) represents the ‘’border” between north sector and south sector of the Romanian littoral. The sands from the shallow waters have medium size (174 mm) particle diameter. 8 species were found at Constanta, H. flexus and M. littorale usually being more abundant in spring. D. tisboides with a very large eurytopic properties is considered here as subdominant. The endemic Mesochra pontica appeared in some samples from this area. Most species are quartered at 1 m depth. At Eforie Nord – Belona beach (Lat. 44º N 03,756; Long. 28º E 38,479) and Eforie Sud – Capul Turcului (Lat. 44º N 01,635; Long. 28º E 39,426) 14 species were recorded. Ectinosoma melaniceps take the first rank with a W of 27, 22 % and 29, 30 %, being euconstant and eudominant in both zones. As a typical interstitial form, Halectinosoma herdmani become one of the six constant and dominant species. S. pontica, Paralaophonte brevirostris, M. pontica, C. furcigera, Ameira parvula, Thalestris longimana and Parathalestris dovi are accessories coming, largely from higher infralittoral. Very abundant become at Costinesti (Lat. 43º N 56,896; Long. 28º E 38,292), Nitocra elongata being characteristic for coarse sands of this zone. Heterolaophonte stroemi paraminuta has a 100% frequency with 52 ind.·m^{-2} abundances.A uniform distribution of encountered individuals in different depths it was observed. At Mangalia (Lat. 43º N 49,005; Long. 28º E 35,279) it was found 10 harpacticoids species, many of them with high abundances, very frequent (80 -100%) and with ecological significance indices values up to 24,78 as C. perplexa, H. herdmani, and N. elongata. Their depth preferences are here on 0, 5 m where the dynamic of the water is less felt at sediments level and the oxygen is still in optimum quantities. The situation is maintained in the final site, Vama Veche (Lat. 43ºN 46,880; Long. 28º E 34,798) where middlittoral and infralittoral sands shelter 11 harpacticoids species. The total populations’ abundances reach 809 ind.·m^{-2}, but with low densities, of 122 ind.·m^{-2}. The characteristic species are the same as in the former two northern sites, sharing the first five ranks, as eudominant and dominant, being encountered in all samples. As an accidental species was recorded Klieonychocamptus kliei ponticus, isolated in some samples.

Harpacticus littoralis and *Dactylopodia tisboides*, are accessory and receding species and *Schizopera pontica* is an accidentalone. In the next southern site, at Mamaia – Hotel Parc (Lat. 44º N 13,176; Long. 28º E 38,191), among the 13 recorded species, besides those already mentioned before, we can notice *Nitocra typica* as subdominant, with a uniform distribution in studied transects. In these interstitial spaces where the

Conclusions

- Five taxa - *Canuella perplexa*, *Halectinosoma herdmani*, *Microarthridion littorale*, *Harpacticus flexus* and *Harpacticus littoralis* consistently present in the north sites, are found in southern areas too, although their density in these biotopes varies from 5 - 35 ind.·m^{-2}.
- Some species which are accidentally in the northern sector areas become dominant in many stations of south region (for example *Ectinosoma melaniceps*, which reaches densities between 15 - 37 ind.·m^{-2}).
- Typical endopsammic harpacticoids *Arenopontia subterranea*, *Parastenocaris chappuisiOnychocamptus mohammed are adapted to mesoporal spaces, having filiform bodies and under 0, 5 mm lenght. But they are recorded as isolated, accidental species in Romanian Black sea shallow waters.* and

References

1 - SERBAN M., 1959.Les Copepodes de la Mer Noire. Note preliminaire sur les Harpacticides de la cote Roumaine. *Lucr. Ses. St. a Stat. Zool. Marine “I. Borcea", Agigea* : 259-300.

2 - POR F., 1960. Harpacticoide litorale de la coasta N-V a Marii Negre. *Trav. Du Mus. D’Hist. Natur. “Gr. Antipa”*, 2: 97-145.

3 - GEORGESCU A., MARCUS A., SERBAN M., 1962. Les Harpacticoides de la R.P.R.*Trav. Du Mus. D’Hist. Natur. “Gr. Antipa”*, 3: 75-92.

4 - - POR F., 1964. A study of the Levantine and pontic harpacticoida (Crustacea, Copepoda).*Zool.*Verhandelingen:1-128.

5 - SAMARGIU M. D., 2001. Some aspects of harpacticoids (Crustacea, Copepoda) biology from the Romanian Black Sea coast. *Natural Science, 3-rd International Conf. of PhD Students, University of Miskolc, Hungary*: 59 – 67.

6 - SAMARGIU M. D., 2005. A study of harpacticoids (Crustacea, Copepoda) from the rocky faces of the Romanian shore. *Natural Science, 4-th International Conference of PhD Students, University of Miskolc, Hungary*: 155-163.

TROPHIC RELATIONSHIP BEETWEEN *LOLIGO VULGARIS* AND *POSIDONIA OCEANICA* IN CATALAN WATERS (NW MEDITERRANEAN)

Pilar Sanchez [1]*, Montserrat Demestre [1] and Silvia De Juan [1]
[1] Institut de Ciències del Mar-CSIC - pilar@icm.csic.es

Abstract
The possible trophic relationship between *Posidonia oceanica* and the abundance of *Loligo vulgaris* in the Catalan coast (NW Mediterranean) was investigated. The results suggest that food source of *Loligo vulgaris* is closer to *Posidonia ocenica* than to phytoplankton.
Keywords: Behaviour, Cephalopods, Western Mediterranean

Introduction
L. vulgaris distribution extends along the eastern Atlantic, from the North Sea and British Islands (55º N) to the south-western coast of Africa (20º S), and also throughout the Mediterranean Sea (1). *L. vulgaris* distribution in the Mediterranean Sea, mainly concentrates in areas shallower than 100 m. It generally inhabits temperate waters. In the Mediterranean, *L. vulgaris* is mainly a by-catch of the multispecies bottom trawl fisheries, throughout the year. Near the coasts where it concentrates during autumn and winter for spawning, small-scale professional and sport fishermen usually target it using hand-jigs. Juveniles recruit to the fishery at approximately three-four months age (2). The purpose of this work is to study the possible trophic relationship between *Posidonia oceanica* and the abundance of *L. vulgaris* in the Catalan coast (NW Mediterranean).

Material and Methods
Sampling was carried out on board commercial trawlers on a monthly basis, from October 2003 to December 2005 in Roses, Blanes and Cambrils Catalonia ports (NW Mediterranean). The landings and landings-per-unit-effort, LPUE data were obtained from the DGPAM (General Direction of Fishing and Maritime Affairs) of the Catalan Government for the period 2000-2005. Data of stable carbon isotope are from th project "Avaluaciò de l'estat de les poblacions de *Loligo vulgaris* a Catalunya" financed by Autonomous Government of Catalonia. Isotopic value of *Posidonia oceanica* is -14.3 (s.d.=0.153) and for phytoplankton -23.6 (s.d=0.71).

Results and Discussion
LPUE data series showed a clear pattern of abundance from North (Llança) to South (Sant Carles) (Fig.1) being more abundant in the North and Central areas than on the South. It is well known that temperature is an important factor in the recruitment of the species (3) but not the unique. The distribution of *Posidonia oceanica* in Catalan waters is shown in figure 2. Posidonia meadows are more abundant in North and Central area of study. Our objective was to use stable carbon (C) isotope ratio of the mantle of *Loligo vulgaris* to typify the trophic state of the species and its relationship with *Posidonia oceanica*. Food sources were investigated using a mixing model based on phytoplankton and *Posidonia oceanica* source isotopic composition data previously obtained. Isotopic values of mantle of *Loligo vulgaris* varied between -17.3 (s.d. =0.2) in Cambrils, 17.4 (s.d.=0.1) in Blanes and -18.5 (s.d.=0.2) in Roses. Our results suggest that source of food of *Loligo vulgaris* is closer to *Posidonia ocenica* than to phytoplankton. This doesn't mean that *Loligo* eats directly on *Posidonia* but belongs to a tropic net where *Posidonia* is an important source of carbon.

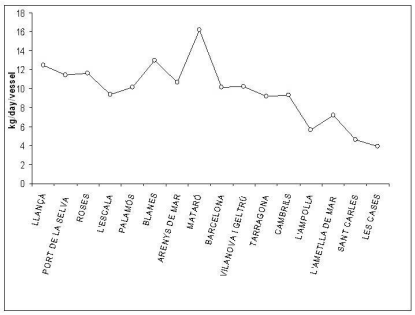


Fig. 1. Mean CPUE (2000-2008) of *Loligo vulgaris* on 16 ports of Catalan coast. From North (Llança) to South (Sant Carles)

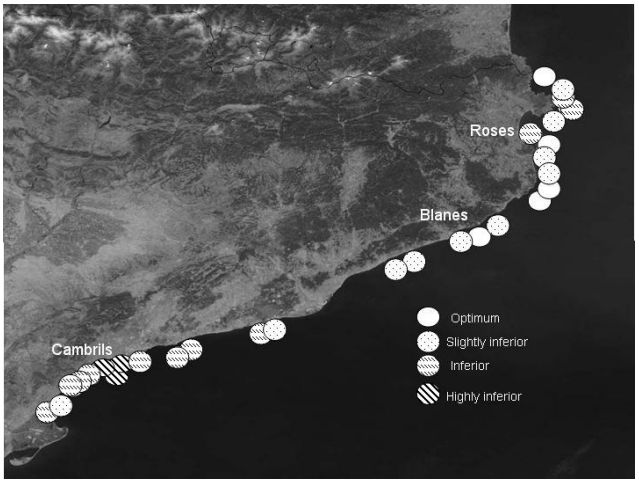


Fig. 2. Qualitative presence of *Posidonia oceanica* on Catalan coast. Redrawn from www.cram.org

References
1 - Guerra A., 1992. Mollusca, Cephalopoda. In: Fauna Ibérica. Museo Nacional de Ciencias Naturales. SIC. Madrid. 327 pp.
2 - Guerra A., Sanchez P. and Rocha, F., 1994. The Spanish fishery for *Loligo*: Recent trends. *Fish. Res*., 21 (1-2): 217-230.
3 - Sanchez P., Demestre M., Recasens L., Maynou F. and Martin P., 2008 Combining GIS and GAMs to identify potential habitats of squid *Loligo vulgaris* in the Northwestern Mediterranean. *Hydrobiologia*, 612:91-98.

THE PROJECT FOR-MARE: TRAINING AND RESEARCH IN MARINE PROTECTED AREAS, MARINE ECOLOGY AND GEOBOTANY STAGES

Dario Savini [1]*, Gilberto Parolo [1], Chiara Lombardi [2] and Anna Occhipinti [1]
[1] Dipartimento di Ecologia del Territorio, Università di Pavia, Via S. Epifanio 14, I-27100 Pavia - dario.savini@unipv.it
[2] Centro Ricerche Ambiente Marino - ENEA, C.P.224, La Spezia, Italy

Abstract
The FOR-MARE project aims to create a network of expertises among Universities, Research Centres, Schools and Diving Associations in order to realize stages for students from University and teachers from primary and secondary schools. Its major objectives are: 1) expanding knowledge of the role of Marine Protected Areas (MPA); 2) promoting 'scientific tourism'; 3) helping MPAs in scientific data collection and monitoring programs.
Keywords: Marine Parks, Instruments And Techniques, Coastal Waters, Coastal Management, Monitoring

Marine Protected Areas (MPAs) represent a concrete effort of national administrations to preserve biodiversity and promote scientific research [1]. Currently, in Italy there are 20 MPA that care as a whole for about 184,000 ha of sea and 580 km of littoral. Notwithstanding their importance, Italian MPA are encountering a period of recession in relation to the world economic crisis, as they represent a "non productive sector of the national economy" in strict sense. The project FOR-MARE, namely translating from Italian to English: "Training and research in marine protected areas, stages of marine ecology and geobotany", born with the aim of broadcasting the role of MPA by creating "scientific tourism" in these areas. In June 2009 the Section of Ecology of the "Dipartimento di Ecologia del Territorio" of the University of Pavia promoted a first, pilot, taught course of Applied Ecology in the MPA of Isole Pelagie (Sicily) [2] in order to test a new teaching method in the field. Nineteen students from the University of Pavia with background experience in Biology, Ecology and Botany participated to this stage. In a week time (21/06-28/06/2009), students have been driven by teachers to prepare and present small scientific works on issues concerning population ecology of coastal marine organisms and terrestrial plants following a didactic scheme that consisted in:
1) providing theoretical knowledge by tutorial lessons;
2) conducting general surveys of the study area by snorkeling and trekking;
3) building up an experimental design (e.g. building also material used for visual census survey such as quadrats) (Fig. 1);
4) collecting biological and ecological information in the field using non destructive methodologies;
5) reporting scientific results to the public. The stage produced four small studies that provided new knowledge on local marine fauna and terrestrial flora: 1) Description and population structure of an unidentified actinia 2) Distribution and population density of the alien grapsid crab *Percnon gibbesi* 3) Morphometry and reproductive biology of *Pancratium linosae* (Amaryllidaceae) 4) Floristic characterization of the southern littoral of Linosa Island
All studies produced very interesting preliminary results, worth of scientific deepening. The first study led to the characterization of a peculiar population of the common actinia *Cereus pedunculatus* that in Linosa Islands was found only in a very restricted bathymetric range range (20-150 cm) of sheltered areas and is characterized by a dark –brown morph and small individuals (oral disc major axis < 5 cm). The second, revealed that the alien grapsid crab is the dominant crab species of the medium-superior infralittoral fringe; the highest density (51 ± 28 ind. $10m^{-2}$) of *P. gibbesi* is found in partially sheltered localities characterized by a microhabitat of large boulders covered by coralline algae. The third, gave the benefit of the doubt on the correct taxonomic position of the island endemic sea-daffodil *Pancratium linosae*, that by morphometric analysis appeared more similar to the most common species *Pancratium maritimum.* Finally, the fourth and last study revealed the presence of 11 species of local flora, not mentioned in pre-existing floristical lists of the island and of a consistent population of the Eolian endemic species *Limonium algusae* never mentioned before. Results of the stage FOR-MARE strengthen once again the importance of volunteer based programs in scientific data collection as already pointed out by other ongoing international programs (e.g.Seasearch, UK; The International CIESM Jellywatch Program) [3,4]. A future aim of the FOR-MARE project is to establish a solid network of interest on the subject by involving administrators of the territory, universities and research institutes, schools, diving centers/associations and media.



Fig. 1. Students of the FOR-MARE pilot stage (Linosa Island, 2009) are building up survey instruments.

References
1 - Agardy M.T., 1994. Advances in marine conservation: the role of marine protected areas.*Trends Ecol. Evol.*, 9: 267-270.
2 - Savini D. and Parolo G., 2009. 1° Stage dI Ecologia Applicata Isola di Linosa 21-28 Giugno 2009 - Relazione delle attività svolte.Dipartimento di Ecologia del Territorio, Università di Pavia, 17pp.
3 - Sandra B., Marzano M., Cent J., Kobierska H., Podjed D., Vandzinskaite D., Reinert H.Armaitiene A. Malgorzata GJ. and Muršic R., 2008. What counts? Volunteers and their organizations in the recording and monitoring of biodiversity. *Biodivers Conserv.*, 17:3443–3454.
4 - Silvertown J., 2009. A new dawn for citizen science. *Trends Ecol. Evol.*, 24: 467-471.

COMPARISON OF TRAWL SURVEY AND COMMERCIAL DATA ON SMALL PELAGICS FROM THE FAO GEOGRAPHIC SUB-AREA 9 (WESTERN MEDITERRANEAN)

M. Sbrana [1]*, S. De Ranieri [1], A. Ligas [1], B. Reale [1], I. Rossetti [2] and P. Sartor [1]
[1] Centro Interuniversitario di Biologia Marina ed Ecologia Applicata (CIBM), Livorno - Italy - msbrana@cibm.it
[2] Aplysia Soc. Coop. r.l., Livorno - Italy

Abstract

Trawl survey data on *Engraulis encrasicholus* and *Sardina pilchardus* have been compared with the official available statistics on landings in the FAO Geographical Sub-Area 9 (GSA9). A high correspondence between the two sources of data has been found for anchovy, while for sardine the two data series showed some differences with an evident decresing of the survey index and more fluctuating trend for landing data.

Keywords: Pelagic, Trawl Surveys, Fisheries, Ligurian Sea, Tyrrhenian Se

Introduction

Anchovy, *Engraulis encrasicholus*, and sardine, *Sardina pilchardus*, are two of the most important pelagic marine resources in the FAO Geographic Sub-Area 9 (Ligurian Sea and Northern and Central Tyrrhenian Sea). In this area a well developed fishery targeting them with purse seine is performed by the local fleets and by vessels coming from the south of Italy during the fishing season. Official statistics show that the biomass landed in this area represents a significant portion of the total landing registered in Italy for these two species. In spite of this, no specific scientific surveys have been carried out in the past in order to evaluate the biomass at sea and to collect information useful to assess the exploitation state of these two important resources. Since 1994, the GSA9 has been included in the MEDITS project for the evaluation of the demersal resources [1]. Although this survey is targeted to investigate species living near the bottom, the characteristics of the net employed (high vertical opening of the mouth) allow to regularly catch species living in the water column, as the small pelagics. The present study aims to compare the trends in biomass of the two populations with the commercial landings. A possible correspondence in the trends of the two data series will strengthen the possibility to use MEDITS surveys data also as valuable indicator of the abundance of small pelagic species.

Materials and Methods

The study was performed in the FAO GSA9, where the experimental trawl survey MEDITS has been carried out from the beginning of the project (1994) to the present. The gear used for the data collection is a bottom trawl designed for experimental fishing with scientific purpose [2]. The net vertical opening slightly higher (2.5 m) to that of the most common professional gears allows to significantly catch species less related to the bottoms like small pelagics. A cod end of 20 mm mesh size (stretched mesh) is employed. The experimental hauls have been allocated by means of a stratified sampling design with random drawing inside each depth stratum. Although the surveys cover the shelf and the upper slope from 10 to 800 m depth, the time series of mean biomass (kg/km^2) were calculated for the macro-stratum 10-200 m, where the two investigated species are concentrated. A biomass index (kg/km^2) has been computed according to Souplet [3]. Official statistics on commercial landings to be compared with survey data have been provided by the Italian Istituto Nazionale di Statistica (ISTAT) for the period 1994-2000 (www.istat.it); since 2001 the Istituto di Ricerche Economiche per la Pesca e l'Acquacoltura (IREPA) has been charged to monitor the economic aspects of the Italian fishing sector, including landing statistics (www.irepa.org). For each species, the two time series were analysed by means of the cross-correlation function [4].

Results and discussion

MEDITS data for anchovy shows high biomass indices of this species in the period 1999-2003, whilst the minimum values are observed in the last years. A similar trend of the total landing recorded in the GSA9 is found, with maximum biomass landed in correspondence to that estimated at sea. For this species a significant cross-correlation has been obtained (r = 0.54). For sardine the correspondence between experimental and commercial data is less evident. Landing statistics and trawl survey biomass estimations showed a very high parallelism just for the period 1994-1999. In the case of the trawl survey data, the trend is characterised by a drastic and continuous decrease; landing decreased till 1997 and high fluctuations of the values are observed in the period 2000-2008. For sardine the cross-correlation resulted not significant. The good correspondence between landing and survey trends supports MEDITS survey as a promising descriptor of anchovy abundance at sea, at least in absence of more precise data. In the case of sardine, the decreasing trend obtained from MEDITS data does not fully match with landing data. In spite of this, MEDITS could represent an useful source of information also for this species. However, it is important to take into account that sardine is not the target of the small pelagic fishery, thus is not landed on a regular basis. When anchovy is abundant, the fishermen avoid to land sardine and larger amount of the species is often rejected at sea.

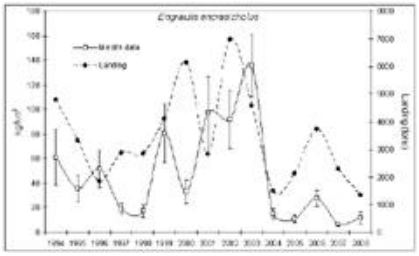


Fig. 1. *Engraulis encrasicholus*. Trends of the MEDITS biomass index (kg/km^2 +/- standard deviation) and total landing in the GSA9

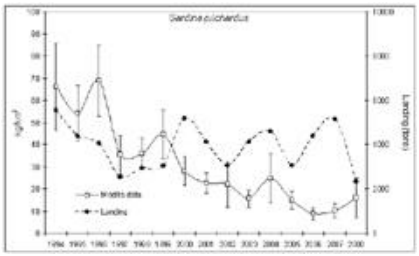


Fig. 2. *Sardina pilchardus*. Trends of the MEDITS biomass index (kg/km^2 +/- standard deviation) and total landing in the GSA9

References

1 - Bertrand J.A., Gil de Sola L., Papaconstantinou C., Relini G., Souplet A., 2002. The general specifications of the MEDITS survey. *Sci. Mar*., 66 (2): 9-17.

2 - Fiorentini L., Dremière P.-Y., Leonori I., Sala A. and Palombo V., 1999. Efficiency of the bottom trawl used for the Mediterranean international trawl survey (MEDITS). *Aquat. Living Resour*., 12 (3): 187-205.

3 - Souplet A., 1996. Calculation of abundance and length frequencies in the MEDITS survey. In: J. Bertand (ed.), Campagne internationale de chalutage demersal en Méditerranée (MEDITS). Campagne 1995, Vol. III. Rapport final de contract CEE - IFREMER - IEO - SIBM - NCMR (MED/93/020, 0, 18, 006, 004).

4 - Cleveland, R.B., Cleveland, W.S., McRae, J.E. and Terpenning, I., 1990. STL: a seasonal-trend decomposition procedure based on Loess. *J. Official Statistics* 6, 3 –73.

REACTIONS OF BENTHIC PREDATORS TO MORTALITY EVENTS: A TIME-LAPSE APPROACH

Lucie Schiemer [1], Bettina Riedel [1], Martin Zuschin [2]* and Michael Stachowitsch [1]
[1] University of Vienna, Dept. of Marine Biology
[2] University of Vienna, Dept. of Paleontology - martin.zuschin@univie.ac.at

Abstract
The Northern Adriatic Sea is a case study for globally increasing coastal hypoxia and anoxia. We documented the course of events after experimentally induced, small-scale (0.25 m²) mortalities here. The time-lapse camera revealed a clear sequence of predators and scavengers – fish, hermit crabs and gastropods – that removed the dead and decaying organisms within several days. Post-anoxia processes should be incorporated into management plans for sensitive areas.
Keywords: Adriatic Sea, Anoxia, Fishes, Mortality, Behaviour

Introduction
Hypoxia and anoxia are key, and increasing, threats to shallow coastal ecosystems worldwide [1]. The Northern Adriatic Sea is a recognized area for hypoxia- and anoxia-related community changes and mortalities [2]. Little, however, is known about immediate post-anoxia events and long-term recovery. We employed a new system (EAGU; Fig. 1) which creates and fully documents small-scale anoxia (50 x 50 x 50 cm) *in situ* [3]. The instrument combines photo-documentation with detailed chemo-physical analyses (sensor array) and allows the behaviors and mortalities of benthic organisms to be analyzed during and after oxygen depletion.

Material and Method
The EAGU device was positioned on a soft-bottom in 24 m depth (two deployments: August, September 2009) in the Gulf of Trieste, Northern Adriatic Sea. The system was initially positioned in a closed configuration (plexiglass chamber) over benthic organisms for 60 h to induce mortality. Then, the open configuration (aluminium frame) was used for another 2–3 d. The EAGU yielded ca. 6000 images which can be viewed and analyzed separately or as a film.

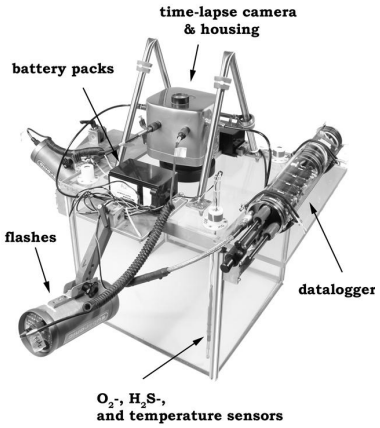


Fig. 1. Experimental Anoxia Generating Unit (EAGU) with instrument lid on plexiglass chamber. ch: camera housing, dl: datalogger, eb: battery, fl: flashes, os: oxygen sensor, sp: sensor port

Results and Discussion
The EAGU successfully created anoxia within three days, and most benthic organisms died. Analogous to dredge damage [4], the moribund/dead organisms attracted predators/scavengers, which removed most of the dead material within days. The analysis showed that fish (*Gobius niger*; *Diplodus vulgaris*, *Serranus hepaticus*) were the first post-anoxia visitors (after 9 min); their numbers gradually decreased during the deployment, suggesting that most of the suitable dead material was consumed early. The second and third group arriving were hermit crabs and gastropods. They mainly fed on remains not used by fishes (e.g. sponges, ascidians) (Fig. 2). After extreme events, measurements need to be taken to protect the remaining living marine resources.

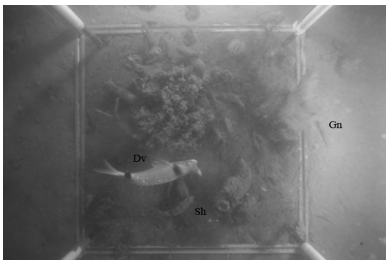


Fig. 2. Three fish species initially attracted by benthic mortality (Gn *Gobius niger*; Dv *Diplodus vulgaris*, Sh *Serranus hepaticus*)

References
1 - Diaz R., 2001. Overview of hypoxia around the world. *J. Environ. Qual.*, 30: 275- 281.
2 - Stachowitsch M., 1984. Mass mortality in the Gulf of Trieste: the course of community destruction. *P.S.Z.N.I. Mar. Ecol.*, 5: 243-264.
3 - Stachowitsch M., Riedel B., Zuschin M. and Machan R., 2007. Oxygen depletion and benthic mortalities: the first in situ experimental approach to documenting an elusive phenomenon. *Limnol&Oceanogr: Methods*, 5: 344-352.
4 - Jenkins S.R., Mullen C., Brand A.R., 2004. Predator and scavenger aggregation to discarded by-catch from dredge fisheries: importance of damage levels. *J. Sea. Res*. 51: 69-76.

BIOLOGIE ET DYNAMIQUE DU COPÉPODE CALANOIDE *COPIDODIAPTOMUS NUMIDICUS* DANS LE RÉSERVOIR BENI MTIR (NORD DE LA TUNISIE)

I. Sellami [1], A. Hamza [2], M. El Bour [2], A. Bouaïn [1], H. Ayadi [1] and N. Annabi-Trabelsi [1]*
[1] Faculté des sciences Sfax, 3000 Tunisie, - neilaannabi@yahoo.fr
[2] Institut National des Sciences et Technologies de la Mer, 2025 Salammbô, Tunisie

Abstract
Ce travail porte sur l'étude de la biologie et de la dynamique du copépode calanoïde *Copidodiaptomus numidicus* du réservoir Beni Mtir au cours d'un cycle annuel, qui s'étend du mois de mars 2005 au mois de janvier 2006. Les résultats montrent que les facteurs abiotiques et biotiques ont une influence sur la distribution de cette espèce.
Keywords: Copepoda, Zooplankton

Introduction - Les copépodes sont constamment confrontés à des variations des facteurs abiotique et biotique, tels que la température, la quantité et la qualité de la nourriture rencontrée, qui peuvent agir sur leur croissance et leur reproduction ou sur le déroulement de leur cycle de vie [1]. Le copépode calanoïde *Copidodiaptomus numidicus* est l'espèce dominante du zooplancton de la plupart des réservoirs de la Tunisie [2]. Au cours de l'étude du zooplancton du réservoir Beni Mtir, nous avons noté l'importance quantitative de ce copépode calanoïde (64% du zooplancton total). L'objectif de ce travail est d'étudier la biologie et la dynamique du copépode *Copidodiaptomus numidicus* dans le réservoir Beni Mtir.

Matériel et méthodes - Site d'étude et stratégies d'échantillonnage : Ce réservoir a été construit en 1953, il est situé dans le gouvernerat de Jendouba entre 36°43′10″ de latitude Nord et entre 08°44′10″ de longitude Est à 30 Km de la ville d'Ain Draham, afflue de la rive Nord du fleuve Medjerdah, principal cours d'eau de la Tunisie. Cette retenue de barrage est alimentée par l'oued E'lil. Elle a un volume de 57,6 millions m d'eau pour une superficie de 310,6 ha et de hauteur maximale de 78 m. Le bassin versant couvre une surface de 103 km . Ce barrage est une source importante d'approvisionnement en eau potable de Tunis et de la production d'énergie électrique. Les prélèvements destinés aux analyses physico-chimiques et biologiques ont été effectués, selon une fréquence mensuelle de mars 2005 à janvier 2006 (sauf pendant les mois d'avril et de décembre à cause d'un problème logistique), sur toute la colonne d'eau (surface, 5m, 10m et 15m) au niveau de la station tour de prise. Analyses physico-chimiques et biologiques : La température de l'eau, le pH, les concentrations en oxygène dissous et la salinité ont été mesurés à l'aide d'une sonde multiparamètres de type Multi 340 i/SET. Les éléments nutritifs ont été dosés par colorimétrie en utilisant un auto analyseur de type 3. Les concentrations en chlorophylle 'a' ont été déterminées par spectrophotométrie après extraction à l'acétone 90%. Les échantillons de zooplancton ont été prélevés en utilisant un filet à plancton de type JUDAY de porosité 80 µm et préservés dans une solution de formol à 5%. Cette espèce a été identifiée selon Dussart [3].

Résultats et discussions - Le développement de l'espèce *Copidodiaptomus numidicus* est caractérisé par une densité maximale de l'ordre de 51,1 ind.l le 22 juillet 2005 (Fig. 1). Ce paroxysme est dû au développement le plus important des stades copépodites jeunes (C1, C2 et C3) (7,8 ind.l) et préadultes C4 et C5 (19,0 ind.l).

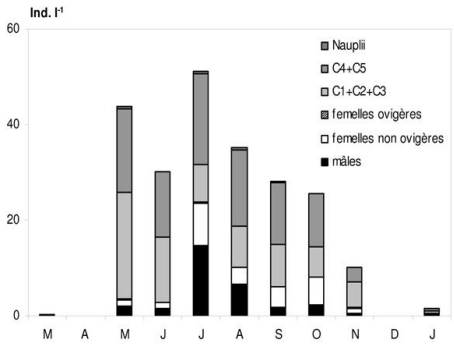


Fig. 1. Variation spatio-temporelle de la densité de *C. numidicus* dans le réservoir Beni Mtir

L'analyse en composantes principales de la matrice regroupant les paramètres physico-chimiques et biologiques permet de selectionner les deux axes qui ont le maximum de variance (Fig. 2). L'axe F1, qui extrait 38,26% de la variance, sélectionne positivement le groupement G1 constitué par la température, la conductivité, les concentrations de la chlorophylle 'a', les nauplii, les copépodites C4+C5, les mâles, les femelles ovigères et non ovigères. L'axe F2 qui extrait 21,76% de la variance sélectionne positivement le groupement G2 formé parles copépodites C1+C2+C3 et la salinité. Les résultats montrent que l'espèce *Copidodiaptomus numidicus* se développe essentiellement pendant la saison printanière et estivale. Tandis que les faibles densités ont été enregistrées pendant l'hiver (mois de janvier). Une corrélation positive a été mise en évidence entre les copépodites C4+C5, qui sont les plus abondants, et la température (r=0,850, p<0,05, ddl=16). De même, il y a une correlation significative entre cette espèce et les concentrations en chlorophylle 'a' (r= 0,837, p<0,05, ddl=16). La variabilité de la température de l'eau et les concentrations en chlorophylle-a affecte visiblement la dynamique et la reproduction des copépodes [4].

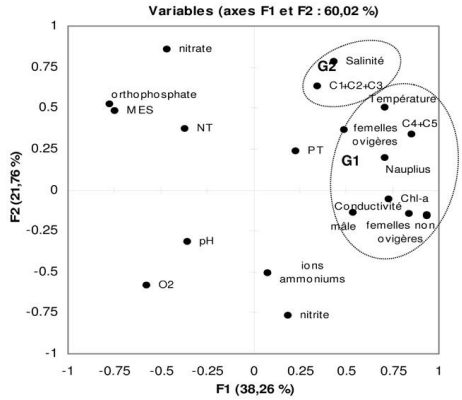


Fig. 2. Diagramme de l'analyse en composante principale : oxygène dissous (O_2), azote total (NT), phosphore total (PT), matières en suspension (MES), Chlorophylle-a (Chl-a)

References
1 - Caramujo M.J., Boavida M.J., 1999. Characteristics of the reproductive cycles and development times of *Copidodiaptomus numidicus* (Copepoda: Calanoida) and *Acanthocyclops robustus* (Copepoda: Cyclopoida). *J. Plankton Res.*, 21: 1765-1778.

2 - Sellami I., Ayadi H., Bouain A., Aleya L., Alaoui Mhamdi M., 2009. Distribution of zooplankton related to environmental factors in three interconnected reservoirs: Kasseb, Mornaguia and Ghdir El Goulla (North of Tunisia). *Ann. Limnol. - Int. J. Lim.*, 45: 107–117.

3 - Dussart B., 1969. Les copépodes des eaux continentales d'Europe occidentale. Tome II : Cyclopoides et biologie quantitative .N. Boubée et Cie, Paris, 292p.

4 - Devreker D., Souissi S., Winkler G., Forget-Leray J., Leboulenger F., 2009. Effects of salinity, temperature and individual variability on the reproduction of *Eurytemora affinis* (Copepoda; Calanoida) from the Seine estuary: A laboratory study. *Journal of Experimental Marine Biology and Ecology*, 368: 113–123.

VARIATIONS OF CARPET SHELL CLAM (*TAPES DECUSSATUS*, LINNAEUS 1758) BENTHIC JUVENILES IN ÇAKALBURNU LAGOON, IZMIR, TURKEY

S. Serdar [1]*, A. Lök [1], A. Küçükdermenci [1], A. Kirtik [1], S. Acarli [1], M. Güler [1], G. Metin [1], S. Yigitkurt [1], H. Yildiz [2] and S. Çolakoglu [3]

[1] Ege University, Faculty of Fisheries, 35100, Bornova-Izmir, TURKEY - serpil.serdar@ege.edu.tr

[2] Canakkale Onsekiz Mart University, Fisheries Faculty 17100 - Canakkale, TURKEY

[3] The Ministry of Agriculture and Rural Affairs, 17100 - Canakkale, TURKEY

Abstract

Two stations were selected in Çakalburnu Lagoon, Izmir, Turkey for determining amount of *Tapes decussatus* benthic juveniles. The maximum clam spat in St.1 and St. 2 were obtained 35 juvenile / 100 cm^2 (in November) and 15 juvenile / 100 cm^2 (in March), respectively. There was not detected any clam in February, April and June (St. 1) and in April and May (St. 2).

Keywords: Bivalves, Aegean Sea, Recruitment

Introduction

The dynamics of planktonik larval populations have important implications for the life histories of marine benthic invertebrates [1]. An increased knowledge of bivalve larvae and settlement ecology will allow a better understanding of environmental processes that determine the magnitude of bivalve recruitment [2] and larval recruitment processes and survival of juveniles influence the bivalve population dynamics.

In Turkey, carpet shell clam, *Tapes decussatus,* is distributed along the all coastline except from Black Sea. Mainly, *Tapes decussatus* is collected from Izmir Bay, especially in Çakalburnu Lagoon and this species has a commercial value in Turkey. But production of clam is based on wild stocks and there is not any aquaculture facility. So amount of clam juveniles is important for natural stocks and sustainable production. This study was conducted for determining abundance of juvenile clam in Çakalburnu Lagoon, Izmir Bay, Turkey.

Material and Methods

Çakalburnu Lagoon (150 ha acreage) in Izmir Bay, Aegean Sea was selected for the study site, located at the south part of Izmir Bay (Fig. 1). The study was conducted in two stations in inside of lagoon. Field sampling was carried out monthly during a year. Environmental parameters such as temperature, salinity, chlorophyll-a, total particulate matter (TPM) and phytoplankton species were determined each month.

Benthic juvenile clam are aggregated largely with in the upper 1.0 cm of the sediment. Three sediment samples were collected at each station using a core sampler (5.0 cm diameter). The samples were fixed immediately with 5 % formalin and dyed with Rose Bengal to simplify sorting the specimens of settled bivalves under a loupe.

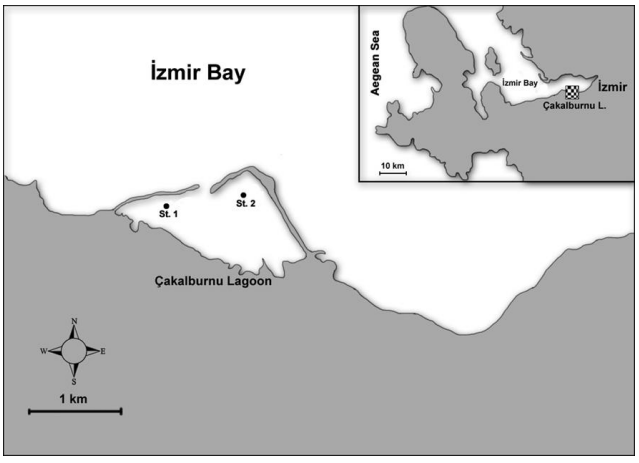


Fig. 1. Map of study site

Results and Discussion

Sea water temperature was between 13.2 °C and 28.6 °C throughout the study. Salinity value ranged from 36.1 ‰ to 38.5 ‰. Chlorophyll a value was determined between 4.71 µg L^{-1} and 24.02 µg L^{-1} in St. 1 and from 1.89 µg L^{-1} to 58.40 mg L^{-1} in St. 2. The average TPM concentration was found 11.19 mg L^{-1} in St. 1 and 16.56 mg L^{-1} in St. 2. Species belonging to Dinophyceae and Bacillarophyceae group were identified the most in terms of phytoplankton species composition in two stations. The maximum amount was obtained 35 juvenile / 100 cm^2 in St. 1 (in November) and 15 juvenile / 100 cm^2 in St. 2 (in March) (Fig. 2). There was not detected any clam in February, April and June (St. 1) and in April and May (St. 2) ($p<0.05$).

Newly settled of Manila clam in Tokyo Bay, Japan was observed mainly between May and October [3]. Our results showed similar to results of [3]. Moreover, in Nameishi, Japan, amount of Manila clam benthic juveniles was 90 ind. / 100 cm^2 [4]. Although our results lower than results of [4], Çakalburnu Lagoon was productive area for clam settlement.

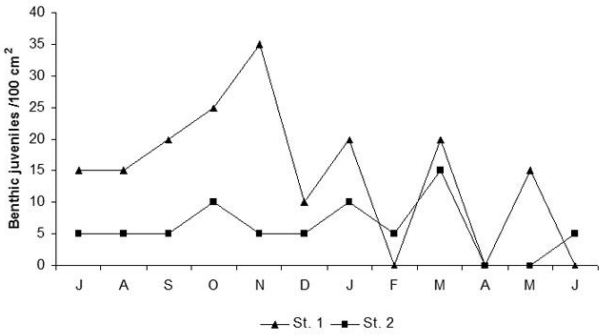


Fig. 2. Amount of benthic juveniles in two stations

Acknowledgement : This study is the part of the project "Reproduction and growth characteristics of carpet shell clam (*Tapes decussatus* Linnaeus, 1758) in Çakalburnu Lagoon area", (Project No: ÇAYDAG - 105 Y 256), supported by The Scientific and Technological Research Council of Turkey.

References

1 - Hines A.H., 1986. Larval problems and perspectives in life histories of marine invertebrates. *Bull Mar Sci* 39: 506-525.

2 - Chicharo, L., Chicharo, M. A., 2001. Effects of environmental conditions on planktonic abundances, benthic recruitment and growth rates of the bivalve mollusc *Ruditapes decussatus* in a Portuguese coastal lagoon. *Fisheries Research* 53: 235-250.

3 - Toba, M., Yamakawa, H., Kobayashi, Y., Sugiura, Y., Honma, K., Yamada, H., 2007. Observations on the maintenance mechanisms of metapopulations, with special reference to the early reproductive process of the Manila clam *Ruditapes philippinarum* (Adams&Reeve)in Tokyo Bay. *Journal of Shellfish Research*, Vol. 26, No.1.

4 - Ishii, R., Sekiguchi, H., Nakahara, Y., Jinnai, Y., 2001. Larval recruitment of the Manila clam *Ruditapes philippinarum* in Ariake Sound, southern Japan. *Fisheries Science*; 67:579-591.

SUBLITTORAL SOFT-BOTTOM ZOOBENTHIC COMMUNITIES AND DIVERSITY OF SOUTHERN COAST OF THE BLACK SEA (TURKEY)

M. Sezgin [1]*, F. Kirkim [2], E. Dagli [2], A. Dogan [2], A. Ünlüoglu [3], T. Katagan [2] and H. A. Benli [3]
[1] Sinop University Fisheries Faculty Department of Hydrobiology TR57000 Sinop, Turkey - msezgin@sinop.edu.tr
[2] Ege University Fisheries Faculty Department of Hydrobiology TR35100 Bornova, Izmir, Turkey
[3] Dokuz Eylül University Institute of Marine Sciences and Technology TR35340 Inciralti, Izmir, Turkey

Abstract

The macrozoobenthos of Southern Black Sea coast (Turkey) was quantitatively investigated in May-July 1999. Samples taken at 39 stations (13-79 m depth range) provided the basis for the analysis of the distribution of 130 species and 6335 individuals of benthic invertebrates, as well as of their abundance and biomass. Most common species in the studied soft bottoms were, by numbers of individuals, *Melinna palmata*, *Lentidium mediterraneum*, *Lucinella divaricata* and *Chamelea gallina*. The polychaets *Micronephths* cf. *maryae*, *Aricidea fragilis mediterranea*, and *Chone filicaudata* for the entire Black Sea coast and *Eumida sanguinea*, *Mysta picta*, and *Prionospio (Prionospio) steenstrupi* represents new records for the Turkish Black Sea coast.
Keywords: Zoobenthos, Biodiversity, Black Sea

Introduction

The Black Sea is the largest (537. 000 km^3) permanently stratified marine basin of the world [2]. In southern part coasts the shelf is only a narrow intermittent strip. Although the coastal area is free of hydrogen sulphide, concentrations increase rapidly under the thermocline due to the restricted circulation of deeper shelf water. Consequently, the number of macrobenthic species decreases rapidly with increasing depth. Zoobenthos of the Turkish sublittoral zone of the Black Sea has not been thoroughly investigated yet. The aim of this study is to determine the faunistic composition and the main macrozoobenthic communities occurring off the southern coast of Black Sea. The factors that may affect species distribution are also discussed.

Material and Methods

To analyse macrozoobenthos, at each station (total 39) bottom a single quantitative sample was taken using a van Veen grab (0.1 m^2) (Figure 1).

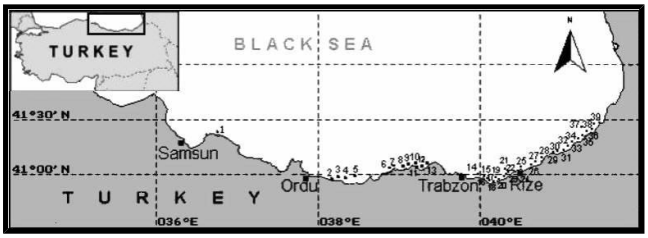


Fig. 1. Map of the study area, indicating the sampling stations

All samples were washed through a 0.5 mm mesh sieve. Thereafter, all macrofaunal organisms were sorted using a binocular microscope, identified, counted and stored in 70% alcohol. Some physicochemical parameters were measured. Frequency index, percentages of animals in relation to total faunal abundances and biomass were calculated for delineating the community structures.

Result and Discussion

In the study region, the average oxygen level was 7.95 ml-1 between 10 and 25 m depth, and it dropped to 4.9 ml-1 at 25-50 m. At a depth of 50-80 m, average oxygen level was 1.25 ml-1. Temperature and salinity values were 15.9 C and 17.5 psu at 10-25 m, 8.8 C and 18.7 psu at 25-50 m, and 7.9 C and 18.9 psu at 50-80 m, respectively. The analyses of grab samples revealed a total of 130 benthic species belonging to Actinaria (one species, two individuals), Nemertini (one species, 10 individuals), Nematoda (one species, 17 individuals), Polychaeta (50 species, 3126 individuals), Phoronida (one species, 28 individuals), Pycnogonida (one species, three individuals), Crustacea (30 species, 490 individuals), Mollusca (42 species, 2373 individuals) and Echinodermata (3 species, 286 individuals). This study added three new records to entire Black Sea and 3 new records to inventory of marine fauna inhabiting the coast of Turkish Black Sea.Polychaeta accounted for 49.3% of total number of specimens, followed by Mollusca (37.4%) and Crustacea (7.9%). The dominant species in the area were *Melinna palmata* Grube, 1870 (28% of total individuals), *Lentidium mediterraneum* (8.5%), *Lucinella divaricata* (7.9%), *Chamelea gallina* (7.7%) and *Aricidea fragilis mediterranea* (5.9%), all comprising 83.5% of total specimens. Special attention should be paid to the distribution of the opportunistic polychaet causing sediment bioturbation *M. palmata*. Gomoiu [3] deduced that the populations of *M. palmata* from the Romanian Black Sea shelf are able to process up to 4.8-9.6 kg of mud/m^2/day. In our research we found that this species has a mean abundance of 450 ind. m^{-2}. Low dissolved oxygen values of lower layer and soft substratum of sediment resulted in wide distribution of *M. palmata*, adapted to these conditions. Molluscs were among the second abundant taxa, accounting for 32% of the total number of macrofaunal species. Among molluscs, gastropods dominate in species number (24 *vs* 18 of bivalve species), but bivalves are much higher as average density (534 ind. m-^{2} *vs* 72 ind. m^{-2}). The commonest bivalve, *C. gallina* (69%) had a highest frequency value of the 39 stations, followed by the bivalve, *P. rudis* (64%), the gastropod, *Cyclope neritea* (59%), respectively. Crustaceans are a qualitative and quantitative key component of the benthic fauna on soft and hard substrata [1]. In study area, Crustacea fauna was mainly composed of Amphipoda (70%), Cumacea (13%), Decapoda (10%), and Tanaidacea (7%), by numbers of species. Of the total of 30 benthic crustaceans, 15 species were encountered at a single station only. The commonest cumacean, *Pseudocuma longicornis* (37%) had a highest frequency value of the 39 stations, followed by the cumacean, *Iphinoe tenella* (33%), the amphipod, *Ampelisca diadema* (33%), the cumacean, *Iphinoe elisae*, and the amphipod, *Perioculodes longimanus* subsp. *longimanus*, respectively. The highest dominance value according to number of individuals was found for the cumacean, *I. elisae* (25%), followed by *I. tenella* (17%), the amphipod *A. diadema* (16%), the cumacean, *P. longicornis* (11%), and the amphipod, *Bathyporeia guillliamsoniana* (6%). Mutlu et al. [4] also mentioned that these same species were abundantly observed in this study area. Total numbers of species diversity for each group on the soft bottoms decreases with depth. Peaks of species diversity are at <50 m, in relatively shallow water zones: 10-25 and 25-50 m. Depth apparently has a major influence on the composition of the fauna, especially above the 50 m level.The most frequent species were *M. palmata* (present in 85% of the samples), *Micronephths* cf. *maryae* (72%), *C. gallina* (69%), *Pitar rudis* (Poli, 1795) (64%) and *A. fragilis mediterranea* (59%). Mollusca accounted for 76% of the total biomass in all samples, followed by Polychaeta and Echinodermata. The species with the highest individual biomass were *C. gallina*. Our investigations have shown that the abundance, biomass and ratio of zoobenthos in the biocoenoses mostly depend on the type of bottom sediments, physcochemical parameters and on the depth of the sea. This study provides useful information about the composition and distribution of benthic invertebrate fauna in Turkish Black Sea coast. Further investigations should be devoted to analyzing species relationships and resource partitioning between species to better understand the dynamic of zoobenthic assemblages.

References

1 - Kirkim F., Sezgin M., Katagan T., Bat L., Aydemir E., 2006. Some benthic soft-bottom crustaceans along the Anatolian coast of the Black Sea. *Crustaceana*, 79(11): 1323-1332.

2 - Sorokin YU.I. ,1983. The Black Sea,. *In*: P.H. Ketchum (ed.), Ecosystems of the World: Estuaries and Enclosed Seas, Elsevier: Amsterdam, pp. 253-291.

3 - Gomoiu M. T.,1982. On the populations of *Melinna palmata* Grube at the romanian littoral of the Black Sea. *Cercetari marine.*, 15: 115-131.

4 - Mutlu E., Ünsal M., Bingel F., 1992. A preliminary view on the faunal assemblage of softbottom crustaceans along the nearshores of the Turkish Black Sea. *Acta Adriatica*, 33(1/2):177-189.

TOWARDS INCREASING GELATINOUS PLANKTON BLOOMS IN THE MEDITERRANEAN. COMPARISON WITH THE BLACK SEA SIMILAR EVENT SCENARIO

Tamara Shiganova [1]*
[1] P.P.Shirshov Institute of oceanology RAS - shiganov@ocean.ru

Abstract
During last years native gelatinous species considerably increased population size and distribution areas in the coastal areas of the Mediterranean Sea. Some of them expanded into the Sea of Marmara and even to the Black Sea. In addition non-native gelatinous species are recorded more and more often in the Mediterranean. We try to assume possible reasons based on nutrients concentration and climate shifts using the Black Sea scenario.
Keywords: Coastal Waters, Ctenophora, Medusae

In the Mediterranean Sea gelatinous species such as coelenterates and ctenophores increased their populations and areas of distributions during last years. Among them scyphomedusae *Pelagia noctiluca*, *Cotylorhiza tuberculata*, *Rhisostoma pulmo*. *ScyphomedusaChrysaora hysoscella, and* ctenophore *Bolinopsis vitrea* not only increased their areas of distribution but also expanded into the Sea of Marmara and even to the Black Sea [5]. Lessepsian migrant scyphomedusa *Cassiopea andromeda* established, spread over the eastern Mediterranean and penetrated into the Sea of Marmara [6]. The Black Sea invader *Mnemiopsis leidyi*, which was mainly observed in the Aegean Sea and did not create semi-reproductive population, in 2009 was recorded during all summer in new locations along the eastern and western Mediterranean Sea [1, 2, 3,7]. *Spreading mucilage* also increase in new areas. Although blooms of gelatinous plankton species have often been observed in the Mediterranean, particularly pronounced in the early 1980's, there is still almost no information about their effective causes, or of correlations which would enable prediction of their occurrence. Scenario of gelatinous plankton blooms in the Mediterranean has been compared with the Black Sea one. The Black Sea ecosystem resulted in nutrient pollution altered into a critically eutrophic in 1970s with catastrophic consequences and disturbed functioning. These conditions were favorable for the development of gelatinous plankton. First native gelatinous species began to increase their populations. Rising temperature in addition to disturbance are favored the naturalization of the gelatinous predatory warm-water ctenophore *M. leidyi* and its penetration into other seas of Mediterranean basin. It reached high abundances and affected all levels of the most ecosystems. Later on appearance in the Black Sea its predator warm water ctenophore Beroe ovata has facilitated ecosystem recovering. Since 1980s similar nutrient content alterations has been recorded in the coastal areas of Mediterranean linked to change their input from the rivers [4]. We assume that this factor together with temperature rise could be drivers of ecosystem change towards gelatinous blooms both native and non-native.

Therefore the Black Sea example must be taken into consideration for understanding reasons of gelatinous plankton blooms in the Mediterranean Sea and focusing new research.

References
1 - Boero F., Putti M., Trainito E., Prontera E., Piraino S., Shiganova T. 2009. First records of *Mnemiopsis leidyi* (Ctenophora) from the Ligurian, Thyrrhenian and Ionian Seas (Western Mediterranean) and first record of *Phyllorhiza punctata* (Cnidaria) from the Western Mediterranean. Aquatic Invasions. V.4.(4): 675-680.

2 - Fuentes VL, Atienza D., Gili J-M and Purcell JE 2009. First record of *Mnemiopsis leidyi* A. Agassiz 1865 off the NW Mediterranean coast of Spain. Aquatic Invasions. V.4 (2): 315-318.

3 - Galil B, Kress N and Shiganova T 2009. First record of *Mnemiopsis leidyi* A. Agassiz, 1865 (Ctenophora; Lobata; Mnemiidae) off the Mediterranean coast of Istrael. Aquatic Invasions 4(2): 356-362.

4 - Ludwig W.,Dumont E.,Meybeck M.,Heussner S. 2009. River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers for ecosystem changes during past and future decades? Progress in oceanography. (in press).

5 - 5.Ozgur E., Ozturk B. 2008. A population of the alien jellyfish Cassiopea andromeda (Forsskal,1775) [Cnidaria, Scyphozoa, Rhizostomea) in the Oludeniz lagoon, Turkey. Aquatic Invasions. V.3.Is.4: 423-428.

6 - Öztürk B., Topaloglu. B. 2009. Distribution of the *Chrysaora hysoscella* from the Istanbul Strait and Turkish part of the Black Sea .National waters days. Abstract. Firat University. Fisheries faculty. Turkey.

7 - Shiganova T, Christou ED, Bulgakova JV, Siokou-Frangou I, Zervoudaki S and Siapatis A. 2004.Study on the distribution and biology of the invader *M. leidyi* in the northern Aegean Sea, comparison with indigenous species *Bolinopsis vitrea.* In: Dumont H, Shiganova T and Niermann U (eds) NATO ASI Series, 2. Environment-. Kluwer Acad. Pub.:113-135.

VARIATIONS SAISONNIERES DE LA BIOMASSE DE *NANOZOSTERA NOLTII* (HORNEMANN) TOMLINSON ET POSLUZNY DANS LA LAGUNE NORD DE TUNIS (TUNISIE SEPTENTRIONALE)

Abdessalem Shili [1]*, Naceur Ben Maïz [2] and Charles François Boudouresque [3]
[1] Institut National Agronomique de Tunisie, 1082, Tunis - shili.abdessalem@inat.agrinet.tn
[2] Société de Promotion du Lac de Tunis, BP 36, Tunis El Bouhaira, 1080 Tunis Cedex, Tunisia
[3] Centre d'Océanologie de Marseille, 13007, France

Abstract
Les Magnoliophytes marines sont réapparues dans la lagune Nord de Tunis après son assainissement et l'amélioration de la qualité de ses eaux. C'est le cas par exemple de *Nanozostera noltii* qui a proliféré, en premier lieu au nord-est de la lagune puis a progressé graduellement vers le sud-est. L'évolution saisonnière de la biomasse de *N. noltii* dans la lagune Nord de Tunis, montre des pics durant les saisons estivales et automnales. Les fluctuations ont été importantes surtout dans la station Nord-ouest où la biomasse totale de *N. noltii* a atteint un maximum de 420 g MS/m^2.
Keywords: Phytobenthos, Biomass, Lagoons

Introduction
Suite à l'assainissement de la lagune Nord de Tunis, plusieurs espèces de Magnoliophytes telles que *Ruppia cirrhosa* (Petagna) Grande, *Cymodocea nodosa* (Ucria) Ascherson et *Nanozostera noltii* (Hornemann) Tomlinson et Posluzny (=*Zostera noltii* Hornemann) ont trouvé les conditions propices à leur développement [1]. *N. noltii* s'est développé en premier lieu dans le secteur Nord-est de la lagune, le plus influencé par les échanges avec la mer Méditerranée ; puis progressivement, son aire de répartition s'est étendue jusqu'au secteur Sud-est. Cette espèce constitue des herbiers homogènes ou bien mixtes avec *Cymodocea nodosa* et *Ruppia cirrhosa*, surtout dans la partie nord de la lagune et avec la Chlorobionte, *Chaetomorpha linum* (O.F. Müller) Kützing, dans la partie sud de la lagune.

Materiel et méthodes
Nous avons étudié la répartition de *N. noltii* dans la lagune Nord de Tunis par observation le long de plusieurs transects nord-sud. Après localisation des herbiers à *N. noltii*, nous avons choisi deux stations au nord-ouest et au sud-ouest de la lagune pour l'étude de la biomasse. Dans chaque station, nous avons relevé la profondeur de l'eau et le recouvrement de *N. noltii* et de ses espèces accompagnatrices. Les prélèvements de biomasses ont été effectués, à raison de trois répliques par station, durant la période allant de janvier 1996 à janvier 1998 à l'aide d'un quadrat de 0,25 m^2. La masse sèche a été mesurée après séchage à 80 °C durant 24 h.

Résultats et discussion
La variation mensuelle de la biomasse de *N. noltii* montre des pics en été et en automne dans la station Nord-ouest de la lagune (fig. 1) où la biomasse totale a atteint un maximum de 420 g MS/m^2. En dehors de la saison printanière, les variations de la biomasse endogée suivent généralement celles de la biomasse épigée. Dans la station Sud-ouest de la lagune, *N. noltii* a essentiellement proliféré durant la deuxième année d'étude (1997). Son maximum de développement a été relevé au printemps avec 134 g MS/m^2. *N. noltii*, espèce euryhaline et préférant les faibles profondeurs et les fonds sablo vaseux [2], [3], a trouvé dans la lagune Nord de Tunis les conditions propices à son développement : faible turbidité et salinité dans les marges de ses tolérances. Elle s'est développée en premier lieu dans les zones Est, le temps de s'acclimater, puis a progressé et proliféré dans le secteur Sud de la lagune.

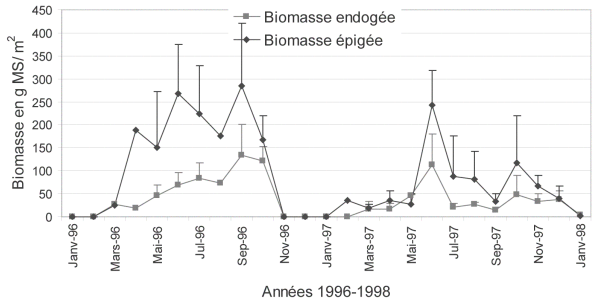


Fig. 1. Evolution mensuelle de la biomasse moyenne de *Nanozostera noltii* dans la station Nord-ouest de la lagune Nord de Tunis. La barre représente l'écart type. L'absence de barre indique un échantillon unique.

References
1 - Shili A. 2008. Les peuplements à *Ruppia* (Monocotylédone, Ruppiaceae) des milieux lagunaires de Tunisie. Thèse Doct., Univ. Aix-Marseille II. pp. 305.
2 - Lovric A.J., 1979. Herbiers benthiques des eaux saumâtres de l'Adriatique orientale. *Rapp. Com. Int. Mer médit.*, p. 25-26.
3 - Boudouresque Ch. F., Bernard G., Pergent G., Shili A., Verlaque M., 2009. Regression of Mediterranean seagrasses caused by natural preocesses and anthropogenic disturbances and stress: a critical review. *Bot. Mar*. 52: 395-418.

SPATIAL DISTRIBUTION OF CTENOPHORE *MNEMIOPSIS LEIDYI* IN AEGEAN SEA

A. Siapatis [1]*, M. Giannoulaki [1], V. D Valavanis [1], A. Machias [1] And S. Somarakis [1]
[1] Hellenic Center For Marine Research - Siapatis@Ath.Hcmr.Gr

Abstract

The invasive ctenophore *Mnemiopsis leidyi* was accidentally introduced into the Black Sea in the early 1980s and it was first sighted in the Aegean Sea in the early 1990s. This paper presents the spatial distribution of *M. leidyi* in Aegean Sea during early summer 2004-2006 and 2008.

Keywords: Aegean Sea, Ctenophora, Plankton

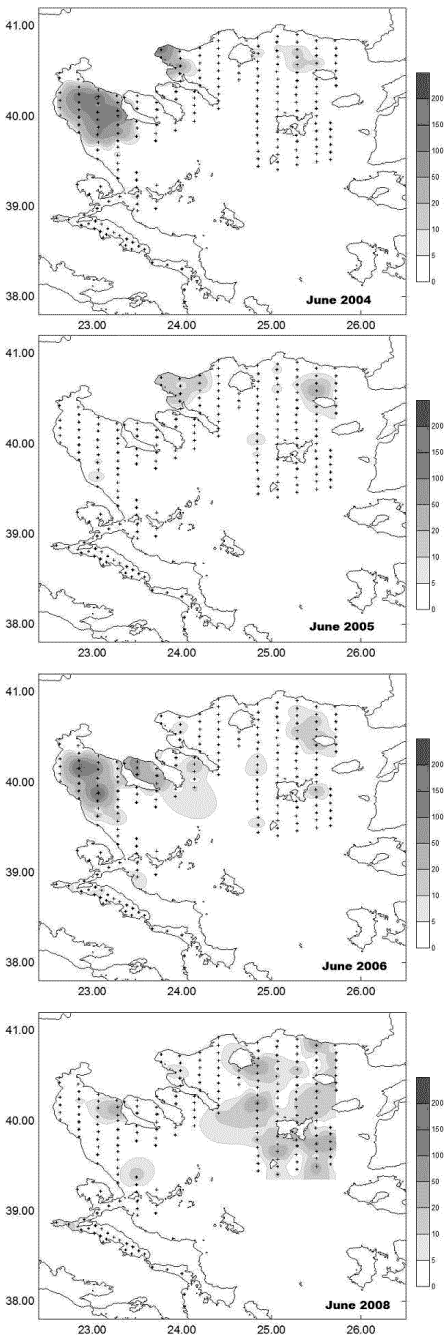


Fig. 1. Distribution maps of *M. leidyi* (individual / m^2) for June 2004, 2005 2006 and 2008 respectively.

Indroduction

The ctenophore *Mnemiopsis leidyi* is a voracious zooplanktivorous species and its native habitat is estuaries and coastal regions along the eastern coast of North and South America. It was accidentally introduced into the Black Sea in the early 1980s [1] possibly with ballast water from ship coming from the northwestern Atlantic coastal region. The first occurrence *M. leidyi* in Aegean Sea was recorded during late spring-summer 1990 in Saronikos Gulf (45-75 ind m^{-2}, [2]). After 1991, *M. leidyi* swarms were observed in several coastal areas of the northern Aegean and few specimens were collected in offshore waters [3]. It is believed that the flow of Black Sea water mass to the northern Aegean Sea contributes to the dispersal of *M. leidyi* in the area.

Materials and methods

Plankton specimens were collected during four research surveys during early summer in the northern Aegean Sea in June 2004-2006 and 2008. Sampling design was based on a grid of stations spaced on parallel transects that were approximately 10 nautical miles apart (Fig. 1). A total of 205 stations were located on 5 nautical miles intervals on each transect. Standard vertical plankton tows were made at each station, by a WP2 sampler (mouth opening: 0.255 m^2, mesh-size: 0.200-mm). *M. leidyi* specimens were identified and counted on board

Results and discussion

The spatial distribution of *M.leidyi* in Aegean Sea in early summer of 2004-2006 and 2008 (including both larvae and adult specimens) are shown in Fig. 1. Although its abundance and distribution shows a large degree of interannual variability, the highest abundances were observed in Thermaikos gulf and Strymonikos gulf where large rivers outflow. The lowest abundances were recorded in June 2005 (3 to 50 ind m^{-2}), whereas the highest in June 2004 (4 to 188 ind m^{-2}). The wider and most southern distribution (up to N. Evoikos Gulf) of the species was observed in 2006 and 2008 compared to the previous years. The percentage of occurrence of *M. leidyi* into the sampling stations increase during the years from 20 and 18% in June 2004 and 2005 to 37 and 50% in June 2006 and 2008. In June 2008 the highest abundances were observed in areas that have been characterised by Black Sea Water influence (e.g. Thracian Sea, Limnos-Imvros plateau), A spatial model has been applied based on Aegean Sea satellite data to determine the environmental conditions that characterize areas where *M. leidyi* is present and based on this to identify other potential areas that could support species presence in the Hellenic and Mediterranean Seas [4]. Furthermore, future work could involve examining whether the local conditions (e.g. temperature, salinity, prey's availability and/or predators' abundance) in the Hellenic Sea could favour *Mnemiopsis* successful reproduction, high populations or bloom levels during all year round that could possibly lead to an alteration of the food web in similar way to the case of the Black Sea.

References

1 - Vinogradov, M.E., Shushkina E.A., Musaeva E.I. and Sorokin P.Y., 1989. Ctenophore *M. leidyi (A. Agassiz) (Ctenophora: Lobata*) - new settler in the Black Sea. Oceanology 29: 293-298.

2 - Shiganova, T.A., Kamakin A., Zhukova D.P., Ushivtzhev V.B., Dulimov A.B. and Musaeva E. I., 2001. New invader in the Caspian Sea - ctenophore *Mnemiopsis* and its initial effect on the pelagic ecosystem. Oceanology 41: 542-549.

3 - Shiganova, T.A., Mirzoyan Z.A., Studenikina E.A., Volovik S.P., Siokou-Frangou I., Zervoudaki S., Christou E.D., Skirta A.Y., and Dumont H.J., 2001. Population development of the invader ctenophore *Mnemiopsis leidyi* in the Black Sea and other seas of the Mediterranean basin. Marine Biology 139: 431-445.

4 - Siapatis A, Giannoulaki M, Valavanis VD, PalialexisA, Schismenou E, Machias A, and Somarakis S, 2008 Modelling potential habitat of the invasive ctenophore *Mnemiopsis leidyi* in Aegean Sea. Hydrobiologia 612: 281-295.

OTOLITH MORPHOLOGY AND FISH SIZE RELATIONSHIPS FOR FIVE WRASSE SPECIES IN THE EASTERN ADRIATIC SEA

Frane Skeljo [1] and Josipa Ferri [1]*
[1] University of Split, Center of Marine Studies - josipa.ferri@unist.hr

Abstract
Sagittal otoliths of five wrasse species, *Coris julis* (Linnaeus, 1758), *Symphodus tinca* (Linnaeus, 1758), *Symphodus cinereus* (Bonnaterre, 1788), *Symphodus ocellatus* (Forsskål, 1775) and *Symphodus rostratus* (Bloch, 1791) were described and compared using morphometric parameters. General otolith shape is the same for all wrasse species, although sagittal morphological variations between the species and different length groups were observed. Results for all investigated species showed that the otolith length is the best indicator of fish total length.
Keywords: Adriatic Sea, Teleostei, Biometrics

Introduction
Otoliths are one of the most useful anatomic fish structures in various studies because of their characteristics (size, morphological specificity and microstructure) and dependence of these properties on the variation in environmental factors [1]. Such applications are widely used by researchers studying feeding ecology of fish predators, although are not just limited to ichthyology. The adequate identification of fish prey from otoliths is essential in feeding studies, where the relationship between otolith length and fish length or weight given by specific regressions can also be used to estimate the prey size or mass. The aim of this study was to investigate otolith morphology of five wrasse species, establish the relationship between otolith size and fish size and to evaluate the usefulness of the otolith shape factors in separation of different wrasse species.

Materials and Methods
Fish samples were collected from the middle eastern Adriatic coast using a beach seine (mesh size 28 mm), from June 2009 to October 2009. The total length (TL) of each wrasse specimen was measured to the nearest mm, weight was measured to the nearest gram, and sagittal otoliths were removed, cleaned and stored dry for afterwards examination. Maximum otolith length (OL), width (h), thickness (d) and weight (OW) were taken for each otolith and its morphology was described [2]. A linear multiple regression model was fitted to the data in order to predict the total fish length from the length, width, thickness and weight of the otolith. The predicitve regression equation took the form $Y = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots + b_ix_i$, where a=constant, b_n=regression coefficients and x_i=independent variables. Forward stepwise multiple regression (probability of alpha to enter <0.15) was used to determine which parameters would best predict total length in selected species.

Results and Discussion
In this study, otolith morphology of *Coris julis* (N=150) ranging from 5.5 to 21.5 cm TL, *Symphodus tinca* (N=144) ranging from 6.5 to 22 cm TL, *Symphodus cinereus* (N=127) ranging from 6.0 to 10.3 cm TL, *Symphodus ocellatus* (N=120) ranging from 5.8 to 9.5 cm TL and *Symphodus rostratus* (N=95) ranging from 7.2 to 11.5 cm TL was described. Based on changes observed in otolith morphology, four otolith categories for *C. julis* and *S. tinca* and two for *S. cinereus*, *S. ocellatus* and *S. rostratus* were distinguished. In general, otolith shape of investigated wrasse species is cuneiform while entire otolith margins are characterized only for *C. julis* and *S. ocellatus*. Anterior part of otolith, including rostrum and antirostrum is well developed in all species except *C. julis*, where antirostrum is poorly defined. On the other hand, *S. tinca* and *S. cinereus* otoliths have deep and acute notch and due to that can be easily distinguished from others. For all species, correlation between fish length and different otolith measurements was statisticaly significant at alpha level of 0.005, with otolith length showing the highest (0.70 – 0.96), and otolith thickness lowest (0.29 – 0.85) values of Pearson correlation coefficient. When a forward stepwise multiple regression model was fitted to the entire data set, the resulting equations excluded variables that did not significantly improve the regression: otolith width for *S. cinereus*, otolith weight for *S. tinca*, and both otolith thickness and weight for *S. rostratus*. For all equations, coefficient of determination (R^2) was reasonably high, ranging from 59.5% for *S. ocellatus* to 93.4 % for *C. julis* (Table 1). However, using only otolith length as prediction variable produces linear regession equations with only slightly lower R^2 values for all analyzed species, except *S. ocellatus* (Table 2). Therefore, use of a multivariate model is probably not justified given the additional work required to measure several parameters, with only slight improvement in the precision of estimated fish length.

Tab. 1. Results of stepwise variable selection using multiple regression model for fish length and otolith measurements

	Variable in model*					R^2 (%)
	Constant	Length (mm)	Width (mm)	Thickness (mm)	Weight (g)	
C. julis	-9,621	60	67	-79	8347	93,4
S. tinca	6,602	53,6	54	-57		87,8
S. rostratus	19,85	31,7	45,1			80,7
S. cinereus	47,6	27,6		-42	13782	62,1
S. ocellatus	38,31	32,4	25	-93	16263	59,5

* Values are coefficients of multiple linear regression equation;
R^2 - coefficient of determination

Tab. 2. Linear regression equations for fish length and otolith length

	Constant*	Length* (mm)	R^2 (%)
C. julis	-28,68	96,7	91,2
S. tinca	13,38	64,1	84,8
S. rostratus	29,63	53,1	74,8
S. cinereus	25,05	42,7	58,5
S. ocellatus	15,82	49,6	49,1

* Values are coefficients of linear regression equation;
R^2 - coefficient of determination

References
1 - Morales N.B., 1987. The influence of environmental factors on microstructure of otoliths of three demersal fish species caught off Namibia. *In*: Payne A.I.L., Gulland J.A. and Brink K.H. (eds.), The Benguela and comparable ecosystem. *S. Afr. J. Mar. Sci.*, 5: 255-262.
2 - Tuset V.M., Lombarte A. and Assis C.A., 2008. Otolith atlas for the western Mediterranean, north and central eastern Atlantic. *Sci. Mar.*, 72: 7-198.

PREMIÈRE MATURITÉ SEXUELLE DE LA CARANGUE COUBALI *CARANX CRYSOS* (OSTEICHTYENS, CARANGIDAE) DU GOLFE DE GABÈS (TUNISIE)

Ayda Sley [1]*, Jarboui Othman [1] and Abderrahmen Bouain [2]
[1] Institut National des Sciences et Technologie de la Mer- Centre de Sfax - Tunisie - seriolafish@yahoo.fr
[2] Faculté des Sciences de Sfax, 3018 Sfax, Tunisie

Abstract
L'étude de la maturité sexuelle chez *Caranx crysos* du golfe de Gabès (Tunisie) a montré que les mâles atteignent la première maturité sexuelle pour une longueur à la fourche (LF) de 210,2 ± 0,6 mm, alors que les femelles deviennent matures lorsqu'elles atteignent une longueur à la fourche de 222,3 ±0,4mm. Dans le cas des sexes confondus, la longueur à la fourche à la première maturité sexuelle est de 216,6±0,5 mm. Chez *C. Crysos*, l'âge théorique de première maturité sexuelle serait de 3 ans pour les femelles et 2 ans pour les mâles.
Keywords: Reproduction, Fishes, Gulf Of Gabes

Matériel et méthodes

L'observation macroscopique de l'évolution des stades de maturation des gonades a été effectuée sur des critères morphologiques (coloration, consistance, importance de la vascularisation superficielle, forme, volume occupé par les gonades dans la cavité abdominale). L'ensemble de ces critères a abouti à l'établissement d'une échelle de maturité [1], [2]. L'examen des gonades mâles et femelles lors de la maturation et de la ponte a permis d'isoler trois classes d'individus ; - des individus juvéniles - des individus de tailles voisines et des individus adultes. Ainsi, les échantillons récoltés durant cette période ont été regroupés par classe de taille de 1 cm pour *C. crysos*. Nous avons dénombré pour chaque classe de taille, séparément, les individus matures et les individus immatures. Par la suite, nous avons calculé la proportion des matures par classe de taille durant la période située entre juin et août correspondant à la période de maturation chez cette espèce dans le golfe du Gabès. La taille de première maturité sexuelle qui correspond à la longueur pour laquelle 50% des individus sont matures a été déterminée en utilisant une fonction logistique qui relie les proportions d'individus mâtures à la taille du poisson. La fonction s'écrit sous la forme : $P=1/(1 + e^{-r\ (L\ -L50)})$, avec P : proportion des individus matures; L : longueur du poisson en cm ; r = constante de l'équation ; L_{50} = longueur à laquelle 50% des individus sont matures. En utilisant le logiciel "FSAS" [3], nous avons ajusté cette équation sur les données obtenues pour la maturité sexuelle chez *C. crysos*. Les résultats concernant les proportions des individus matures prédits (estimés d'après l'équation théorique) ont été analysés statistiquement par le test χ^2 qui est égal à : $\chi^2 = \sum(Mi-nPi)^2/\sum nPi$, où Mi : nombre observé d'individus matures, nPi : nombre estimé d'individus matures. L'âge théorique à la première maturité sexuelle a été déterminé à partir de l'équation de Von Bertallanffy : $t = t_0 -1/K$ Log $(L_\infty-L_t / L_\infty)$ L_t = longueur du poisson au temps t ; L_∞ = longueur théorique pour un accroissement nul ; t_0 = temps théorique correspondant à L = 0 et k = constante de la vitesse de croissance.

Résultats

L'analyse des proportions d'individus matures de *C. crysos* (tableau1) montre qu'à une taille (LF) inférieure à 180 mm, aucun individu, quel que soit son sexe, n'est mature. Par ailleurs, tous les individus observés le deviennent à une taille (LF) supérieure à 250 mm chez les femelles et à 260 mm chez les mâles. Les plus petits et les plus grands adultes observés dans nos échantillonnages mesurent respectivement 182 mm et 358 mm chez les femelles et 181 mm et 351 mm chez les mâles. Les fonctions logistiques pour les femelles, les mâles et les sexes combinés sont déterminés et s'écrivent comme suit : $P= 1/(1 + e^{-0,7345\ (L\ -\ 222,3)})$ pour les Femelles, $P=1/(1+e^{0,5125\ (L\ -\ 210,2)})$ pour Mâles et $P = 1/(1 + e^{-0,5827\ (L\ -\ 216,6)})$ pour les sexes combinés.

- Les mâles de *C. crysos* atteignent la première maturité sexuelle pour une longueur à la fourche de 210,2 ± 0,6 mm (LT= 245,88 mm). Les femelles deviennent matures lorsqu'elles atteignent une longueur à la fourche de 222,3 ± 0,4mm (LT= 259,79 mm). Chez les sexes confondus, la longueur à la fourche à la première maturité sexuelle est de 216,6±0,5 mm (LT=253,12 mm).

- Dans le golfe du Mexique, les femelles de *C. crysos* deviennent matures pour la première fois à une taille de l'ordre de 267 mm de LF [4]. Les données observées s'ajustent bien au modèle logistique. Cette méthode s'applique donc à l'étude de la maturité sexuelle de *Caranx crysos* du golfe de Gabès.

-La fiabilité des résultats est justifiée par le test χ^2. Les valeurs prédites sont presque identiques aux valeurs observées puisque le χ^2 théorique [5] et [6] est nettement supérieur ($\chi^2_{théorique}$ =22,36) au χ^2 observé ($\chi^2_{observé,femelles}$=2,82<, $\chi^2_{observé,mâles}$ =2,04 et $\chi^2_{observé,sexes\ combinés}$=4,95). Dans le cas de *C. Crysos*, l'âge théorique de première maturité sexuelle a été estimé. La maturité sexuelle est atteinte à l'âge de 3 ans pour les femelles et 2 ans pour les mâles.

Tab. 1. Pourcentage des individus matures en fonction de la taille chez les femelles(F), les mâles (M) et les sexes combinés (F+M)de *C. crysos* du golfe de Gabès

Classe de taille (mm)	Effectif (F) imm	Effectif (F) mat	Effectif (M) imm	Effectif (M) mat	F: Pro. mat.	M: Pro. mat.	F+M: Pro. mat.
160<LF<170	11	0	11	0	0	0	0
170<LF<180	17	0	13	0	0	0	0
180<LF<190	6	1	5	3	0,14	0,38	0,27
190<LF<200	7	2	8	5	0,22	0,38	0,32
200<LF<210	16	6	8	6	0,27	0,43	0,33
210<LF<220	13	5	11	10	0,28	0,48	0,38
220<LF<230	7	8	4	8	0,46	0,60	0,52
230<LF<240	3	9	2	7	0,75	0,78	0,77
240<LF<250	1	7	1	11	0,88	0,92	0,90
250<LF<260	0	15	1	16	1	0,94	0,96
260<LF<270	0	7	0	5	1	1	1
270<LF<280	0	1	0	1	1	1	1
280<LF<290	0	12	0	15	1	1	1
290<LF<300	0	11	0	7	1	1	1
LF>300	0	12	0	17	1	1	1

Tab. 2. Paramètres de la taille à la première maturité sexuelle et tests statistiques chez *C.crytos* du golfe de Gabès

Paramètres	Femelles	Mâles	Sexes combinés
r	0,7345	0,5125	0,5827
R : coefficient de corrélation	0,98	0,95	0,96
LF_{50} (mm) ±IC	222,3±0,4	210,2±0.6	216,6±0,5
LF_{25} (mm)	207,3	18,88	197,7
LF_{75} (mm)	237,3	231,6	235,5
$\chi^2_{calculé}$	2,82	2,04	4,95
$\chi^2_{théorique}$	22,36	22,36	22,36

References

1 - Holden M.J. and Raitt D.F.S., 1974. Manual of fisheries science, Part 2: Methods of resource investigation. *FAO Fisheries Technical Paper*, 115: 1-215.

2 - Aboussouan A., and Lahye J., 1979. Les potentialités des populations ichtyologiques : Fécondité et ichtyoplancton. Cybium, 3ième série. (6) : 29 - 46.

3 - Saul B.S., Conrad W.R. and H.P. Michael., 1987. Basic Fishery Science Programs: A Compendium of Microcomputer Programs and Manual of Operation. *Dev. Aquac. Fish. Sci*., 18: 85-125.

4 - Goodwin Iv J.M. & J.H. Finucane., 1985. Reproductive biology of blue runner (*Caranx crysos*) from the eastern Gulf of Mexico. *Northeast Gulf Science* 7:139-146.

5 - Lamotte M., 1967. Initiation aux méthodes statistiques en biologie (2d ed.). 144 p. Paris: Masson & Cie.

6 - Scherrer B., 1984. - Biostatistique (Gaëten Morin, ed.). 850 p. Montréal, Paris, Casablanca

ETUDE MORPHOLOGIQUE DE LA CARANGUE COUBALI *CARANX CRYSOS* (OSTEICHTYENS, CARANGIDAE) DU GOLFE DE GABÈS (TUNISIE)

Ayda Sley [1]*, Othman Jarboui [1] and Abderrahman Bouain [2]
[1] Institut National des Sciences et Technologie de la Mer, Sfax, 3018, Tunisie - sley_aida@yahoo.fr
[2] Faculté des Sciences de Sfax, 3018, Tunisie

Abstract
L'analyse des caractères morphologiques de *Caranx crysos* du golfe de Gabès (Tunisie) a permis d'identifier l'espèce et la distinguer des autres espèces de poissons. L'étude numérique a montré un intervalle bien déterminé de chaque caractère étudié. De plus, le nombre de branchiospines diminue en fonction de la taille et de l'âge du poisson. L'étude biométrique chez les mâles, les femelles et les sexes combinés, a montré que les caractères métriques étudiés sont bien corrélés à la longueur totale et la nature de l'allométrie diffère suivant le caractère utilisé.
Keywords: Biometrics, Fishes, Gulf Of Gabes

Introduction

Caranx crysos (Saint-Hiliaire, 1817) est un poisson très répandu en Tunisie, notamment dans la région Sud du pays (golfe de Gabès) où leur importance commerciale augmente d'une année à l'autre. Dans ce travail, nous nous sommes intéressés à l'étude des caractéristiques morphologiques (numériques et métriques) de cette espèce.

Matériel et méthodes

L'étude a porté sur 270 spécimens de *Caranx crysos* de tailles (LT) comprises entre 95 et 416 mm (85 mm$\leqslant$LF$\leqslant$358 mm). Pour l'étude des caractères numériques, nous avons groupé les mâles et les femelles de cette espèce. Les caractères relevés et analysés statistiquement sont les suivants : le nombre de rayons aux deux nageoires dorsales (D1 et D2) ; le nombre de rayons à la nageoire pectorale droite (P) ; le nombre de rayons à la nageoire anale (A) ; et le nombre de branchiospines au premier arc branchial. Ensuite, nous avons analysé chaque caractère métrique chez les mâles (M), les femelles (F) et les sexes combinés de cette espèce. Ces caractères ont été relevés au millimètre près, à l'aide d'un ichtyomètre et d'un pied à coulisse électronique. Les différentes mensurations effectuées sont les suivantes : la longueur totale (LT) ; la longueur à la fourche (LF) ; la longueur standard (Lst) ; la longueur de la tête (T) ; la première hauteur du corps (H1) ; la deuxième hauteur du corps (H2) ; la longueur de la première nageoire dorsale (LD1) ; la longueur de la deuxième nageoire dorsale (LD2) ; la longueur de la nageoire pectorale (LP) ; la longueur prédorsale 1 (PD1) ; la longueur prédorsale 2 (PD2). Chaque caractère (C) a été décrit par un indice de proportionnalité (I) : I=C*100/LT, où C = caractère mesuré en mm et LT = longueur totale de poisson en mm ; et une fonction puissance (Y) : $Y= aX^{b,}$ où Y = caractère mesuré en mm (variable dépendante) et X = longueur totale en mm (variable indépendante). Après linéarisation de la fonction, les constantes a et b ont été calculées par la méthode des moindres carrés. Selon la loi de l'allométrie, b prendrait une valeur proche de 1. Pour tester cette valeur, nous avons utilisé le test "t" de Student : $t_{cal}= |b-1|/\sqrt{ s^2_y(1-R^2)/s^2_x(n-2)}$; où s^2_y = variance de la variable Y (en Log), s^2_x= variance de la variable X (en Log), R^2 = le carré du coefficient de corrélation, n = nombre d'individus examinés et n-2 = degré de liberté. Ensuite, nous avons comparé t calculé (t_{cal}) à la valeur théorique de t (t_{th}) à un seuil de 5% (Spiegel, 1991) [1].

Résultats

Etude numérique

Caranx crysos du golfe de Gabès possède deux nageoires dorsales séparées par une distance inter dorsale qui augmente avec l'âge (ID). La première dorsale (D1) est courte et épineuse, renfermant huit rayons durs ou épines. Au niveau de la deuxième nageoire dorsale (D2), le nombre des rayons mous varie d'un individu à l'autre et fluctue de 22 à 25. Comme chez tous les Carangidés, *C. crysos* du golfe de Gabès présente une nageoire anale (A) à deux épines coutres et isolées suivies d'un rayon dur et un nombre de rayons mous qui varie de 19 à 21. Les nageoires pectorales (P) sont longues, contenues 0,9 à 1,2 fois dans la longueur de la tête. Le dénombrement de rayons varie de 18 à 21 et il est indépendant de la taille. En revanche, le comptage de branchiospines a montré une diminution en nombre en fonction de la taille et de l'âge du poisson et ce nombre varie entre 33 et 42. En comparaison avec les études effectuées par Fischer et *al.* [2], les formules radiaires de *Caranx crysos* vivant en Méditerranée et en Mer noire et celle peuplant le golfe de Gabès sont identiques.

Etude métrique

Chez *Caranx crysos* du golfe de Gabès, les longueurs de la tête (T) et des hauteurs H1 et H2 et la longueur de la première nageoire dorsale LD1 évoluent selon une allométrie minorante avec la longueur totale. Toutefois, la longueur de la nageoire pectorale (LP) évolue suivant une allométrie majorante. Par ailleurs, la relation entre la taille et les distance prédorsales LPD1 et LPD2 est isométrique. En revanche, la longueur de la nageoire dorsale LD2, varie suivant une allométrie minorante avec la taille chez les mâles, alors que la relation est isométrique pour les femelles (tableau 1). Par ailleurs, les relations entre les différentes longueurs du corps (LT, Lst et LF) montrent de bonnes corrélations justifiées par un coefficient de corrélation R^2 qui varie entre 0,97 et 0,99. Les valeurs de la constante 'b' dans les différentes équations de croissance relative sont proches de l'unité. Chez les mâles, les femelles et les sexes combinés de *C.crysos*, la longueur totale (LT) croît avec la longueur standard (Lst) et la longueur à la fourche (LF) suivant une allométrie majorante. La relation est minorante entre la longueur standard (Lst) et la longueur à la fourche (LF).

Tab. 1. Indices de proportionnalité et équations des relations entre les caractères métriques étudiés et la longueur totale (LT) chez *Caranx crysos du golfe de Gabès*, (F : Femelles ; M : mâles)

Indice	Sexe	$Y=aX^b$	R^2	t_{cal}	t_{th}	Allométrie
T*100/LT	M	$0,26LT^{0,97}$	0,98	3,11	1,96	minorante
	F	$0,28LT^{0,96}$	0,98	3,92	1,97	minorante
	M+F	$0,27LT^{0,96}$	0,98	5,02	1,96	minorante
LP*100/LT	M	$0,09\ LT^{1,18}$	0,96	8,91	1,97	majorante
	F	$0,07LT^{1,22}$	0,98	13,79	1,97	majorante
	M+F	$0,08LT^{1,20}$	0,97	15,69	1,96	majorante
H1*100/LT	M	$0,52\ LT^{0,85}$	0,94	8,11	1,97	minorante
	F	$0,65LT^{0,82}$	0,96	17,76	1,96	minorante
	M+F	$0,591LT^{0,83}$	0,95	14,29	1,97	minorante
H2*100/LT	M	$0,41\ LT^{0,91}$	0,96	5,47	1,97	minorante
	F	$0,47LT^{0,88}$	0,96	7,80	1,97	minorante
	M+F	$0,44LT^{0,89}$	0,96	9,35	1,96	minorante
LD1*100/LT	M	$0,17LT^{0,95}$	0,96	2,80	1,97	minorante
	F	$0,16LT^{0,96}$	0,96	2,30	1,97	minorante
	M+F	$0,17LT^{0,96}$	0,96	4,00	1,96	minorante
LD2*100/LT	M	$0,37\ LT^{0,96}$	0,98	3,32	1,97	minorante
	F	$0,351LT^{0,97}$	0,98	1,92	1,97	isométrie
	M+F	$0,364LT^{0,97}$	0,98	3,43	1,97	minorante
LPD1*100/LT	M	$0,26LT^{1,01}$	0,96	0,84	1,97	isométrie
	F	$0,31LT^{0,98}$	0,97	1,11	1,97	isométrie
	M+F	$0,29LT^{0,99}$	0,96	0,12	1,97	isométrie
LPD2*100/LT	M	$0,38LT^{1,02}$	0,98	1,84	1,97	isométrie
	F	$0,39LT^{1,013}$	0,98	1,16	1,97	isométrie

References

1 - Spiegel M.R., 1991.Théories et applications de la statistique (17th, ed.). 358 p. Paris: McGraw-Hill.

2 - Fischer W., Bauchot M.L. and Schnaider M., 1987. Fiches FAO d'identification des espèces pour les besoins de la pêche, Rév. 1. Méditerranée et Mer Noir, Zone de pêche 37, II : vertébrés. 761-1530.

ROV OBSERVATIONS ON FISH AND MEGAFAUNA IN DEEP CORAL AREAS OF THE EASTERN IONIAN

C. J. Smith [1], C. Mytilineou [1], N. Papadopoulou [1], M. A. Pancucci-papadopoulou [1] and M. Salomidi [1]*
[1] Hellenic Centre for Marine Research - msal@ath.hcmr.gr

Abstract
Under the EU CoralFish project, investigating cold water corals in the Eastern Ionian Sea, sonar targets were surveyed with a remotely operated vehicle at depths of 440-820 m. Information on the bathymetric range, habitat, behaviour, aggregation pattern and response to the ROV is reported for approximately 30 characterising megafaunal and fish species.
Keywords: Fishes, Crustacea, Deep Sea Ecology, Ionian Sea

Introduction
The CoralFish project aims at assessing the interactions between deepwater corals, fish and fisheries, towards better ecosystem based management of European deep waters. Several areas in the North Atlantic and Mediterranean are being investigated. Rich coral communities have been described off the southeast corner of Italy [1]. Off the opposite side of this basin, in western Greece, sites are being investigated to identify and describe coral areas. Observations by remotely operated vehicle (ROV) on megafaunal organisms and their behaviour in their natural environment are reported.

Materials and Methods
The study area is situated off the west coasts of the islands of Cephalonia and Zakynthos (Greek Ionian Sea). Surveys were conducted between 300-2000 m depth in June 2009. Hull mounted multibeam sonar (Seabeam 2021 - 20 kHz) was used to map the general underwater topography, followed by deep tow operations (Geoacoustics Deep Tow 2000; Side scan 114/410 KHz; Sub-bottom Geochirp II, 1-12 kHz) in 4 selected areas. A DSSI Max Rover remotely operated vehicle (ROV) was used to make observations during 5 dives at 440-820 m depth on specific targets and target areas selected from the sonar records. The targets had high potential for deepwater coral occurrence. Live observations were made by scientists on board the support vessel and recorded material in the laboratory. Data analysis included species identification, depth range, habitat, behaviour, aggregation pattern and their reaction to the ROV.

Results
Various species of fish (*Chlorophthalmus agassizi, Hoplostethus mediterraneus, Helicolenus dactylopterus, Pagellus bogaraveo, Polyprion americanus, Phycis blennoides, Chauliodus sloanii, Lampanyctus crocodilus, Nezumia sclerorynchus, Hymenocephalus italicus, Etmopterus spinax, Nettastoma melanurum, Bathypterois mediterraneus, Stomias boa)*, decapods (*Aristaeomorpha foliacea, Aristeus antennatus, Plesionika giglioli, P. martia, P. edwardsii)*, cephalopods (Teuthoidea), anthozoa (*Isidella elongata, Leiopathes glaberrima, Desmophyllum crystagalli, Funiculina quadrangularis*) echinodermata (*Stichopus regalis, Hymenodiscus coronata, Cidaris cidaris*) and cirripedia were observed during the ROV surveys. Approximately 13 individual fish, 18 decapods, 2 cephalopods, 5 cirripedia and 47 corals have not yet been identified.
Depth range distribution: species were classified as found a) mainly <500 m depth (e.g. *C. agassizi*, *P. bogaraveo*), b) mainly between 500-700 m (e.g. *H. dactylopterus, H. mediterraneus, A. antennatus*), c) mainly >700 m (e.g. *I. elongata, L. crocodilus, C. sloanii*) and d) in the whole depth range (e.g. *F. quadrangularis*).
Habitat: species were separated into associated with a) mud (e.g. *C. agassizi, I. elongata*) and b) rocks (e.g. *P. bogaraveo, D. crystagalli*).
Behaviour: species were characterised as a) clearly benthic (e.g. *I. elongata, C. cidaris*), b) lying inactive or moving on the bottom (e.g. *P. martia, P. giglioli, H. dactylopterus*), c) staying just above the bottom, but in close relation with it (e.g. *P. bogaraveo, P. americanus, H. mediterraneus, N. sclerorhynchus, H. italicus*), d) lying on the bottom, but also swimming in the water column (e.g. *A. antennatus, A. foliacea*) and e) swimming in the water column (e.g. Teuthoidea).
Aggregation pattern: a) species presenting a schooling pattern (e.g. *P. bogaraveo, P. gilioli*), b) the solitary ones (e.g. *P. americanus, C. sloanii*) and c) those showing a dispersed pattern (e.g. *C. agassizi, P. martia, H. mediterraneus*).
Reaction to the ROV: species were distinguished as a) remaining inactive (e.g. *C. agassizi, P. martia*), b) reacting and leaving the area (e.g. *A. foliacea*), c) reacting, but without leaving (e.g. *H. dactylopterus*) and d) attracted (e.g. Teuthoidea).

Discussion
The results of the present study confirm the megafauna in the deep waters of the Ionian Sea [2]. More species were observed in the present work, probably related to the longer duration of the ROV surveys, the larger depth range and the larger geographical area studied. Although some of the information collected in this study is already known [3 and references therein], new insights were gathered regarding the behaviour of the species. The use of ROVs allows the behavioural study of deep-water species, however, light and noise disturbance need to be considered.

Acknowledgements : The authors would like to thank colleagues at HCMR in particular the geophysical team and ROV support team as well as the captain and crew of the RV Aegaeo. The CoralFish project (http://eu-fp7-coralfish.net/) is funded by the EU and Greek General Secretariat for Research & Technology.

References
1 - Tursi, A., Mastrototaro, F., Matarrese, A., Maiorano P., D'Onghia G., 2004. Biodiversity of the white coral reefs in the Ionian Sea (Central Mediterranean), *Chem. Ecol.* 20 (Suppl. 1): 107-116.
2 - Mytilineou, Ch., Smith C.J., Politou C.-Y., Kallergis, M., Manoussakis, L. & Papathanassiou, E., 2009. Demersal Deep-Water Species Observations During Remote Operated Vehicle Surveys. Proc. 9th Hel. Symp. *Oceanogr. & Fish.*, vol. II: 733-738.
3 - Fishbase: http:\\www.fishbase.org

THE MORPHOLOGICAL DIFFERENCES BETWEEN INDIVIDUALS LIVE AND DEAD GREEN TURTLES (*CHELONIA MYDAS*) HATCHLINGS ON SAMANDAG BEACH IN TURKEY

Bektas Sonmez [1], Sukran Yalcin ozdilek [2] and Deniz Yaglioglu [1]*

[1] University of Mustafa Kemal, Faculty of Fisheries, Department of Fisheries and Basic Sciences, Fisheries Genetics Laboratory - dyaglioglu@hotmail.com

[2] University of Canakkale Onsekiz Mart, Faculty of Education, Secondary Science and Mathematics Education, Department of Biology Education

Abstract

This paper provides information about morphological differences between individuals live and dead green turtles (Chelonia mydas) hatchlings on Samandag beach in Turkey. A total of 146 hatchlings, taken equally from both live and dead, were examined for the morphological differences. The dead hatchlings had smaller all carapace length, fore limp length, hind limp length from both side and lower weight than live hatchlings.

Keywords: Turtles, Eastern Mediterranean

Introduction

Body size and shape have important physiological, evolutional and ecological for sea turtles [1]. The morphology of hatchlings can increase or decrease possibility of their surviving [2]. Generally bigger hatchlings are more talented swimmer and can escape from predators [3]. Hatchling's morphology of sea turtles can be affected from both genetic and maternal characteristic and environmental factors [3,4]. The differences among the size of the hatchling sea turtles can be caused from the structure of hydric and thermal characteristics of surroundings of nest in incubation duration [4,5]. The aim of this study was to evaluate morphological differences between individuals' live and dead green turtles (*Chelonia mydas*) hatchlings on Samandag beach in Turkey.

Material and methods

Data were collected on Samandag Beach (36° 7.500' N 35° 55.100' E) Northern Mediterranean Sea in Turkey during the 2008 and 2009 nesting seasons. A total of 146 hatchlings, taken equally from both live and dead, were measured and 8 measurements were taken (Figure 1) using manual callipers accurate to 0.1 mm. Measures of straight carapace length (SCL), straight carapace width (SCW), curved carapace length (CCL), curved carapace width (CCW), fore limb length (FLL) from both left and right, hind limb length (HLL) from both left and right, weight between live and dead hatchlings were compared [6,7].

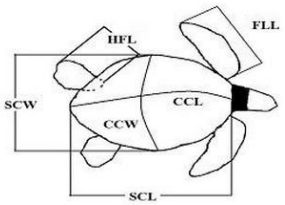


Fig. 1. Measures of straight carapace length (SCL), straight carapace width (SCW), curved carapace length (CCL), curved carapace width (CCW), fore limb length (FLL) from both left and right, hind limb length (HLL) from both

Results and Discussion

The dead hatchlings had smaller SCL (U= 960,00, Z= -6,73, P= 0,000), SCW (U= 1002,00 Z= -6,553, P= 0,000), CCL (U= 1722,00, Z= -3,726, P= 0,000), CCW (U= 1272,00, Z= -5,524, P= 0,000) and lower weight (U= 875,00, Z= -7,040, P= 0,000) than live hatchlings (Table 1). Furthermore, there was significant difference between hatchlings from those in hatchlings from both FLL and HLL for both side, dead hatchlings had smaller left FLL (U= 972,00, Z= -6,699, P= 0,000), right FLL (U= 923,00, Z= -6,901, P= 0,000), left HLL (U= 1863,00, Z= -3,213, P= 0,001) and right HLL (U= 1850,00, Z= -3,274, P= 0,001) than live hatchlings (Table 1).

Peters and Verhoeven (1992) [8] found that there was a significant difference between the sizes of live and dead the loggerhead turtles and suggested that smaller hatchlings were weaker. Similarly, Ozdemir et al. [2] have found that carapace of loggerhaed dead hatchling is smaller for SCL and their weightiness is less than loggerhead live hatchling. Whereas; Loughron et al. (2000) [9] found that there was no significant difference between live and dead hatchlings for SCL, SCW and weight of the green and loggerhead turtles. The larger size may allow hatchlings to escape gape-limited predators, swim faster and to successfully handle larger prey items hatchlings i.e "the bigger is beter" [10]. Generally bigger hatchlings can escape from predators [3]. However, survival of hatchlings can affect negative effect such as its time to leave from the nest of hatchlings, pollution status on beach and amount of light.

Tab. 1. Summarized statistics of the variables taken for live hatchlings and dead

	Live Hatchlings				Dead Hatchlings			
	N	Mean	SD	Min-Max	N	Mean	SD	Min-Max
SCL	73	4.47	0.15	4.10-4.80	73	4.19	0.25	3.60-4.70
SCW	73	3.46	0.19	3.10-4.00	73	3.17	0.26	2.60-3.80
CCL	73	4.82	0.17	4.40-5.20	73	4.68	0.22	4.20-5.20
CCW	73	4.05	0.15	3.70-4.30	73	3.88	0.19	3.40-4.30
Left-FLL	73	4.21	0.14	3.80-4.50	73	3.95	0.26	3.00-4.50
Right-FLL	73	4.21	0.14	3.80-4.50	73	3.94	0.26	3.00-4.40
Left-HLL	73	2.30	0.10	2.10-2.50	73	2.21	0.17	1.80-2.60
Right-HLL	73	2.30	0.09	2.10-2.50	73	2.21	0.17	1.80-2.60
W	73	19.3	1.61	16-23	73	16.43	2.35	12-22

References

1 - Van Dam R.P. and Diez C.E., 1998. Caribbean hawksbill turtle morphometrics. *Bull. Mar. Sci.*, 62 (1): 145 -155.

2 - Ozdemir A., Ilgaz Ç., Kumlutas Y., Durmus S.H., Kaska Y. and Turkozan O., 2007. An assessment of initial body size in loggerhead sea turtles (*Caretta caretta*) hatchlings in Turkey. *Zool. Sci.* 24: 376-380.

3 - Burgess E.A., Booth D.T., Lanyon J.M., 2006. Swimming performance of hatchling green turtles is affected by incubation temperature. *Coral Reefs*. 25: 341-349.

4 - Glen F., Broderick, A.C., Godley, B.J. and Hays, G.C. 2003. Incubation environment affects phenotype of naturally incubated green turtle hatchlings. *J. Mar. Biol. Ass.* U.K. 83: 1183-1186.

5 - Stokes L., Wyneken J., Crowder L.B. and Marsh J., 2006. The influence of temporal and spatial origin on size and early growth rates in captive loggerhead sea turtles (*Caretta caretta*) in the United States. *Herpet. Conserv. Biol.*, 1 (2): 71-80.

6 - Bolten A.B., 1999. Techniques for measuring sea turtles. *In:* Eckert K.L., Bjorndal K.A., Abreu-Grobois F.A., Donnelly M. (eds), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/ MTSG Publication No. 4, pp 110 -115.

7 - Ozdemir B. and Turkozan O., 2006. Carapacial scute variation in green turtle, *Chelonia mydas* hatchlings in Northern Cyprus. *Turk J. Zool.*, 30: 141-146.

8 - Peters, A. and Verhoeven, K.J.F. (1992). Breeding success of the loggerhead, Caretta caretta, and the green, Chelonia mydas, in the Göksu Delta, Turkey. Detp. Of Animal Ecology. University of Nijmegen. Rapport no: 310

9 - Loughron, A.L., Broderick, A.C., Godley, B.J. and Furness, R.W. (2000). Factor affecting size of loggerhead and green turtles hatchlings in Northern Cyprus, Eastren Mediterranean. (Eds: Abrew-Grobois, F.A.,et al.). Proceedings of the Eighteenth International Sea Turtle Symposium. U.S. Dep. Commer. NOAA Tech. Memo. NMFS-SEFSC-436

10 - Janzen, F.J. (1993). An experimental analysis of natural selection on body size of hatchlings turtles. Ecology 74 (2): 332 – 341

SUMMER FISH LARVAL ASSEMBLAGES IN FOUR AREAS OF THE CENTRAL MEDITERRANEAN

Joan Miquel Sorell [1], Patricia Lastra [1], Patricia Reglero [1] and Mari-Luz Fernandez De Puelles [1]*
[1] Instituto Español de Oceanografía - mluz.fernandez@ba.ieo.es

Abstract

Our study confirms that several tuna species spawn in the central Mediterranean, especially in the vicinity of island. Tuna larvae were found in the four areas sampled (Eolias, Cabo Passero, Malta and Aegean Sea) and represented between 18% and 90% of the total abundance. The high larval abundances and occurrence of *Thunnus alalunga* shows that our sampling period coincided with the spawning peak of this species. Other larvae also found in the assemblages included meso-batipelagic, small pelagic and coastal.
Keywords: Ichthyoplankton, Fishes

Introduction

The Mediterranean Sea is an important spawning area for different fish species. The aim of this study is describing the fish larval assemblages in four different areas located in the Central Mediterranean Sea complementing previous surveys in other Mediterranean locations paying special attention to tuna larvae [1]. The presence of larval stages of fish will provide valuable information to describe summer spawning areas for different species in the Central Mediterranean Sea.

Material and Methods

Icthyoplankton samples were obtained within the framework of the oceanographical survey Marviva Med during summer 2008 in four areas in the Central Mediterranean: Eolias (24 stations, from 15th July to 19th July), Cabo Passero (8 stations from 24th-25th July), Malta (5 stations from 25th-26th July) and Aegean Sea (14 stations, from 5th to 11st July). Surface hauls were conducted at 1 m depth using Bongo 90 net equipped with 500 microns meshes. Stations were sampled during daytime and night. Samples were conserved in ethanol. Once in the laboratory, the fish larvae were sorted out and identified to the lowest taxonomic level possible, generally, species level.

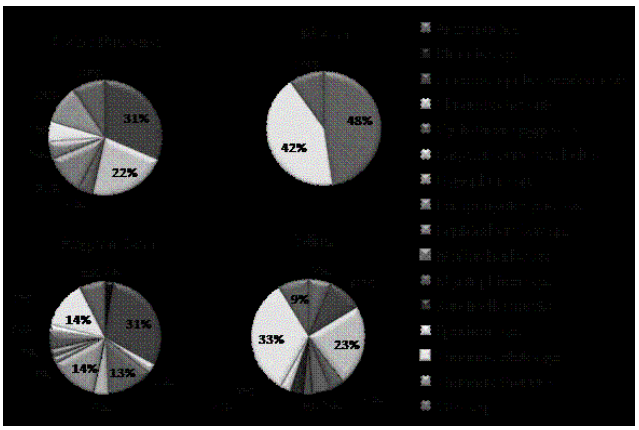


Fig. 1. Fish larval species sampled in each area (Cabo Passero, Malta, Aegean Sea, Eolias). Numbers represent the percentage of each species in relation to the total larval abundance in each area. Only species representing more than 2% of the total abundance were included. All stations within areas were pooled together

Results and discussion

Six species of *Scombridae* were identified but their presence in the different areas differed. Eolias was the area with higher diversity of *Scombridae*, being all species represented, including *Euthynnus alletteratus* which was only found herein, but excluding *Katsuwonus pelamys* that was only found in Malta. *Thunnus alalunga* and *Auxis rochei* were found in all four areas. However, only *Thunnus alalunga* was represented in abundances higher than 2% of the total abundance in each area. In Malta, the larval assemblage was clearly dominated by two species, *Thunnus alalunga* and *Auxis rochei* ,representing around 90% of the total abundance of the fish larval species identified. *Xiphias gladius*, a species included in the red list of UICN, was found in three areas except in Cabo Passero. Inversely, *Thunnus thynnus* was found in Cabo Passero and in Eolias. Larvae of large and medium pelagic species have been found in large quantities also in other areas of the NW Mediterranean Sea, defining specific larval assemblages [2], as in our case occurred in Malta. Our results suggest that the different areas sampled in the Central Mediterranean Sea are spawning areas for *Scombridae* fish and, taking into account the high larval abundances and occurrence of *Thunnus alalunga*, that sampling period coincided with the spawning peak of this species. Larval assemblages were composed by fish groups other than large pelagics. In Eolias, the community was dominated by *Thunnus alalunga* and *Chromis chromis* (a coastal species). Other medium pelagic fish larvae such as *Auxis rochei* was also found in the area. Meso-batipelagic fish species followed in importance. The coexistence of these different groups of larval species has been described in the NW Mediterranean [3] suggesting some similarities in the larval assemblages of NW and central Mediterranean. In the Aegean Sea, meso-batipelagic fish larvae dominated the community represented by *Ceratoscopelus maderensis*, *Cyclotone pigmaea* and Hygophum sp. *Thunnus alalunga* was also represented in the community. *Ceratoscopelus maderensis* and *Lampanyctus pusillus*, belonging to the meso-batipelagic species, dominated the assemblage. Our study confirms that several tuna species spawn in the central Mediterranean, especially in the vicinity of island, and co-occur with larvae of other species.

References

1 - Rooker J.R., Alvarado Bremer J.R., Block B.A., Dewar H., De Metrio G., Corriero A., Kraus R.T., Prince E.D., Rodríguez-Marín E., and Secor D.H., 2007. Life history and stock structure of Atlantic bluefin tuna (*Thunnus thynnus*). *Reviews in Fisheries Science*, 15:265-310.

2 - Sabates A., Olivar M. P., Salat J., Palomera I., and Alemany F., 2007. Physical and biological processes controlling the distribution of fish larvae in the NW Mediterranean. *Progress in Oceanography* 74 (2-3):355-376.

3 - Alemany F., Deudero S., Morales-Nin B., López-Jurado J.L., Jausà J., Palmer M., and Palomera I., 2006. Infuence of physical environmental factors on the composition and horizontal distribution of summer larval ?sh assemblages off Mallorca island (Balearic archipelago, western Mediterranean). *Journal of Plankton Research* 28 (5):473-487.

ASSESSMENT OF MARINE PAINTS BASED ON TUBEWORMS AND SEPIA SHELL

Aida Tadros [1]*, Manal El naggar [1] and Fatma Zaghloul [1]
[1] National Institute of Oceanography and Fisheries (NIOF) - BT_AIDA@yahoo.com

Abstract
Two Marine paints were prepared with the same formulation except one based on tubeworms (AF_t) and the second contains *Sepia* shell (AF_S). The two paints together with their blank (B) were applied on unprimed steel panel and immersed in seawater. The biological investigation of the coated surfaces showed (AF_S) inhibits heterotrophic bacteria, actinomycetes and the sulfate reducing bacteria after 21 days of immersion with 43%, 25% and 64%, respectively, compared to (B). After 70 days of immersion (AF_S) was free from diatoms, primary stages of macroalgae and the polychaet larvae while primary stages of macroalgae were formed on (B).
Keywords: Diatoms, Fouling, Bio-Accumulation, Chemical Analysis

Introduction
The immersed surfaces in marine environment are usually rapidly colonized by microorganisms, includes attachment of bacteria, diatoms, fungi, and protozoans. These are often followed by the settlement of algal spores and larvae of macro invertebrates. The colonization process is termed biofouling [1]. This study aims to evaluate the antifouling property of tubeworms and Sepia shell as natural pigments for marine fouling control.
Each of tubeworms and Sepia shell was incorporated individually in similar marine paint formulation. The paints were applied on unprimed steel panels, immersed in Eastern harbor (EH) and their coated surfaces were biologically assessed.

Material and Methods
Tubeworms have been collected from (EH) and *Sepia* shell is available and easily obtain. Both washed with tap water, distilled water, dried at 70 ºC and grind till fine particle size <71µm using sieves.
Chemical analysis; the total C% of tubeworms and *Sepia* shell was measured in Micro-analytical Center, Fac. of Sci. Cairo Univ.
Spectrophotometer measurement; 0.1g of each of tube worms and sepia shell in 50 ml D.W. was stirred and the spectrum of each solution was measured after 2, 4,7,8,9, and 10 days.
Marine paint formulation was prepared with a composition of oil binder 25, iron oxide 10, zinc oxide 24, and complementary pigments 13. Tubeworms and/or *Sepia* shell were added with 25 % in the paint. The two paint formulations together with the blank were applied on unprimed steel panels 10X10X0.5cm, hanged in a frame and immersed in EH. The condition of the surfaces was followed photographically and biologically inspected [Figs 1&2]. The microbiological examination for heterotrophic bacteria, actinomycetes, sulfate reducing bacteria and marine fungi and the biological investigations for diatom and zooplankton population were carried out for the biofilms formed on (B), (AF_t) and (AF_S) coated steel panels according to the APHA, 1995 [2].

Results and Discussion
The four different microbial communities were monitored after 7, 14, 21 and 21 and 28 days. The diatom and zooplankton formed on the coated surfaces were examined and identified after 70, 85 and 95 days.
The C% was found to be 12.22 % and 13.82% for tubeworms and sepia shell respectively. The spectra of the tubeworms after 8 days showed two absorption bands at 385 nm and 370 nm respectively, while the aqueous medium of the *Sepia shell* showed one absorption band at 270 nm.
The coated steel surfaces were inspected in triplicates for heterotrophic bacteria, actinomycetes and marine fungi after 7, 14, 21 and 28 days of immersion. The data indicated that the maximum inhibition for heterotrophic bacteria, actinomycetes and the sulfate reducing bacteria was observed after the 21 days of immersion on (AF_S). They were significantly inhibited by 43%, 25% and 64%, respectively, compared to (B). After 14 days of immersion the marine fungi showed to be inhibited by 14% on (AF_t) compared to (B).
The results of the biological investigation after 70 days of immersion showed primary stages of macroalgae were formed on (B). Rare numbers of diatoms (*Navicula*, *Cosinodiscus* and *Thalassionema nitzschioides)* and rare numbers of zooplankton species (copepoda, protozoa, and free living nematode and spionoid larvae of polychaet) were recorded on (B) and (AF_t). These species were attached to the coated surfaces from the surrounding seawater, while (AF_S) surface was free from diatoms, primary stages of macroalgae and the polychaet larvae. After 85 and 95 days of immersion, frequent forms of primary stages of macroalgae and rare diatom species (*Skeletonema*, *Nitzschia closterium* & *Navicula*) were formed on all examined steel coated panels (B, AF_t and AF_S) and a detection of only one polycheat larva was observed after 95 day on each examined coated panel. (AF_S) steel coated surface showed better fouling control than (AF_t) over a period of 100 days of immersion.

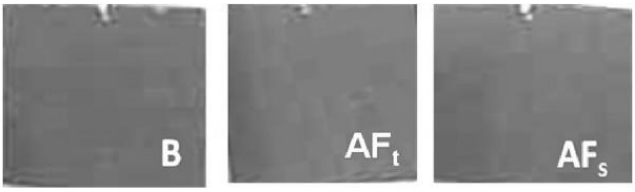


Fig. 1. Coated surfaces before immersion

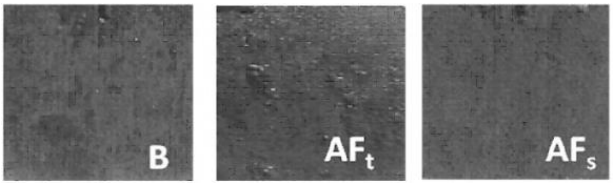


Fig. 2. Coated surfaces after 70 days of immersion

References
1 - Silva-Aciares, F. and Riquelme, C., 2008. Inhibition of attachment of some fouling diatoms and of settlement and germination of *Ulva lactuca* zoospores by film-forming bacterium isolated and their extracellular products isolated from biofouled substrata in northern Chile. *Electro. J. Biotechnol.* [online], 11(1).
2 - American Public Health Association (APHA)., 1995. Standard methods for the examination of water and wastewater. 16th Ed. American Public Health Association, Inc., New York, p 345.

CHANGES IN BENTHIC MACROINVERTEBRATE COMMUNITY IN THE VENETIAN LAGOON (ITALY) 2002-2007

D. Tagliapietra [1]*, E. Keppel [1], G. Pessa [2], A. Rismondo [2] and M. Sigovini [1]
[1] Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine (CNR-ISMAR) - davide.tagliapietra@ve.ismar.cnr.it
[2] SELC

Abstract
Remarkable changes in the benthic communities of Venice lagoon were observed between 2002-2007. The temporal evolution was characterized by a general increase of species richness, numerical abundance, biomass and diversity. There was a rapid change between 2002 and 2003, with an increase of abundance and biomass in the seaward zones of the lagoon. After such a change, these zones stabilized, while for the inner zones the recovery continued in 2007. The communities of the internal areas shifted from an organic-adapted community towards a more marine community. Spatial patterns and typical transitional gradients were evidenced each year. The role of main hydrogeological drivers is also briefly discussed. The study underlines the importance of considering physiographic zones in describing benthic dynamic.
Keywords: Lagoons, Monitoring, Biodiversity, Sediments

We demonstrate changes in the benthic macroinvertebrate community of the Venetian Lagoon between 2002-2007. Sixty stations distributed all over the lagoon were sampled in May-June of 2002, 2003 and 2007 ("MELa Project" Magistrato alle acque di Venezia / Consorzio Venezia Nuova). A zonal approach was adopted, by which changes in benthic communities structure are referred to the different physiographic zones composing the lagoon ecosystem (Rochford, 1951, Roy et al., 2001, Tagliapietra *et al.*, in press). Five physiographic zones were identified: the Marine Tidal Deltas, close to the three sea inlets, the Central Basin and the Sheltered Lagoon, located on the middle ranges of the lagoon and two landward zones; the Fringe zone and the Bayhead Estuary. The temporal evolution was characterized by a general increase of species richness, numerical abundance, biomass and diversity. Both the total number of species and the average number of species per station increased, this trend being more pronounced in the Fringe zone and Bayhead Estuary. The highest species richness was found in 2007 (255 species). The first two years were characterized by a higher number of organic-tolerant species, whereas 2007 presented more sensitive ones. There was an increase of individuals from 2002 to 2003 in all zones, especially in the Sheltered Lagoon. Such an increase was also observed in 2007, but only for the Marine Tidal Delta and the Fringe Zone. Numerical abundances were dominated by polychates and amphipods, being typically higher in the inner zones because of the occurrence of opportunistic species. Also the biomass increased considerably from 2002 to 2003 in the Marine Tidal Delta and the Central basin. In 2007, the increase involved in the inner areas such as the Fringe Zone and the Bayhead Estuary. Minima were recorded in the Sheltered Lagoon. Biomass was dominated by bivalves. Exception to this trend was observed in the Central Basin with a reduction of both abundance and biomass in 2007 compared to 2002-2003. Temporal changes in dominant taxa were reflected in the trophic composition that shifted towards filter feeders. The diversity followed the species number and therefore decreased along the transitional gradient from sea to land. The biomass diversity showed a progressive increase mainly in the inner typologies, as the Fringe zone and the Bayhead Estuary. In every year, species richness correlated mainly to residence times and salinity, then to turbidity and sediment texture. Similarly diversity indexes correlated to species number although with lower coefficients. The environmental variables had a relatively low correlation with similarity matrices of both abundance and biomass. The role of turbidity and sediment organic matter in structuring the lagoon benthic assemblages was also important; as an example in the areas with high turbidity the community is less rich than that expected and characterized by organic-tolerant species. In the multivariate analysis performed on the abundance, the 2007 samples resulted quite different from those of 2002 and 2003 which largely overlapped. The community structure of the internal areas showed a progressive shift towards the Marine Tidal Delta structure. The shift towards a Marine Tidal Delta community structure was more evident for the Fringe Zone samples, especially for those of the Lido Basin. In this context the Bayhead Estuary stations kept their individuality. Biomass showed a temporal evolution similar to that of abundance. In conclusion, we found a rapid change between 2002 and 2003 with an increase of the vigour (abundance and biomass) in the seaward zones of the lagoon. The Marine Tidal Delta areas, after a rapid change, stabilized, while for the inner zones the recovery continued in 2007 with the exception of the Sheltered Lagoon. In 2007 the general overview pointed at an increase of diversity all over the lagoon. This increase was not followed by an increase of vigour in the Central Basin where a sensible reduction of both abundances and biomass was recorded. Our study underlines the importance of considering physiographic zones in describing benthic dynamic.

References
1 - Roy P. S., Williams R. J., Jones A. R., Yassini I., Gibbs P. J., Coates B., West R.J., Scanes P.R., Hudson J.P. and Nichol P., 2001. Structure and function of south-east Australian estuaries. *Estuarine, Coastal and Shelf Science* 53: 351-384.

2 - Rochford, D. J., 1959. Classification of Australian Estuarine Systems. *Archives of Oceanography and Limnology* . 11:171-177.

3 - Tagliapietra D., Sigovini M., Volpi Ghirardini A., 2009. A review of terms and definitions to categorize estuaries, lagoons and associated environments, Marine and Freshwater Research, *Marine and Freshwater Research* 60 (6): 497–509.

4 - Tagliapietra, D., Zanon, V., Frangipane, G., Umgiesser, G., Sigovini, M., (in press). Physiographic zoning of the Venetian Lagoon. CORILA Research program 2004-2007 Results.

THE CRINOID GARDEN OF MONTECRISTO ISLAND MARINE SANCTUARY (TUSCAN ARCHIPELAGO NATIONAL PARK, MEDITERRANEAN SEA)

M. Taviani [1], L. Angeletti [1], A. Ceregato [1]*, B. Gualandi [2], E. Lipparini [1] and D. Malatesta [3]
[1] ISMAR - CNR, Via Gobetti 101, I 40129 Bologna, Italy - alessandro.ceregato@bo.ismar.cnr.it
[2] CNR - Area della Ricerca, Via Gobetti 101, I 40129 Bologna, Italy
[3] ROBOMAR S.a.s. & C., I-00187, Rome, Italy

Abstract
A recent ROV exploration of the deepest part of Montecristo Island (Tyrrhenian Sea) documents the occurrence of an extensive crinoid facies dominated by *Leptometra phalangium* (Müller J., 1841). This Atlantic-Mediterranean crinoid forms dense populations up to 10 individuals /m^2 all around the island in a depth range between ca. 110-130 m, preferentially settling on coarse detrital bottoms.
Keywords: Tyrrhenian Se, Echinodermata, Zoobenthos, Biodiversity, Bio-Indicators

Introduction
The tiny island of Montecristo is located in the eastern Tyrrhenian Sea at 42° 19.9'N, 10°18.5'E. Montecristo is part of the Tuscan Archipelago National Park since 1971. A programme designed at the non-invasive exploration of the flanks of Montecristo island was launched in 2008 to check for the possible presence of deep water corals down to its deepest stretches. Two exploratory surveys were conducted in summer 2008 onboard the m/b *Angélique 1945*, using the Remote Operating Vehicle (ROV) *Prometeo Flat Platform 6+* and the *Global Vision* Video Camera (VC), operated by ROBOMAR sas & Co (Fig.1). The ROV exploration identified and documented for the first time the presence of an extensive crinoid *facies* all around the island starting from 108 m down to a maximum depth of about 132 m.

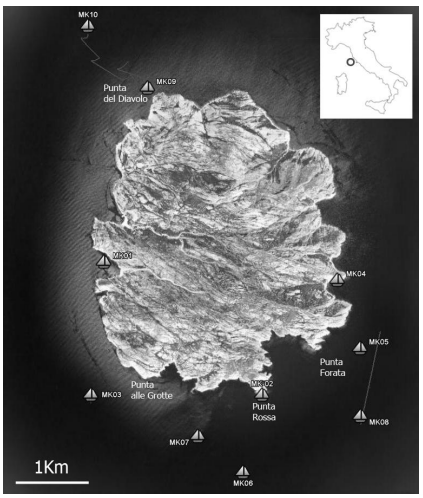


Fig. 1. Island of Montecristo. Map of the surveys

Results and discussion
The most successful transects were carried out at the sites of Punta Rossa, Punta Forata and Punta del Diavolo where the ROV imaged a seabottom characterized by the absolute dominance of crinoids. Spot checks conducted using VC at other locations around Montecristo further confirmed the ubiquity of such crinoid facies that results therefore the most relevant one inhabiting the coarse circalittoral detrital seabottom encircling Montecristo. At the time of our diurnal survey the quasi totality of crinoids were very active in feeding. Since no seabottom sampling was allowed beside corals (not encountered during our ROV investigations) the taxonomic recognition of the crinoid was performed using the video documentation (Fig. 2).

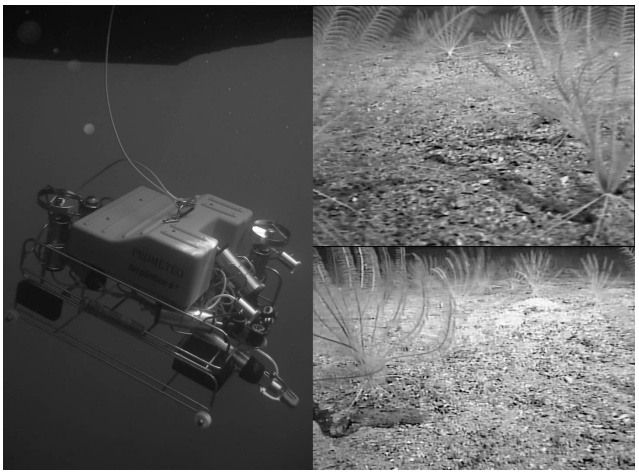


Fig. 2. The ROV during the operations and two snapshots of the "Crinoid garden" taken by the ROV's video equipment

The crinoid has been identified as *Leptometra phalangium* (Müller J., 1841). This is a common echinoderm distributed in the Eastern Atlantic Ocean and Mediterranean Sea ([1], [2], [3], [4]). In the Mediterranean *Leptometra* is well known to contribute to circalittoral communities, and is widespread in the Tyrrhenian Sea, including other sectors of the Tuscan Archipelago ([2]).

Acknowledgements : Thanks are due to the Park authorities for granting permission to work in the waters of Montecristo. SCUBA divers Michele Ghirelli and Antonio Sperottihelped with ROV buoyancy calibration.

References
1 - Bianchi C. N., Boero F., Fraschetti S., Morro C., 2005. Marine Fauna (Including Brackish Waters). *In*: Blasi C., Boitani L., La Posta S., Manes F., Marchetti M. eds. Biodiversity in Italy. *Palombi Ed*.: 312-360.
2 - Colloca F., Carpentieri P., Balestri E., and Ardizzone G. D., 2004. A critical habitat for Mediterranean fish resources: shelf-break areas with *Leptometra phalangium* (Echinodermata: Crinoidea). *Mar. Biol.*, 145 (6): 1129-1142.
3 - Pellegrini D., Sartor P., 1989. Distribuzione spazio-temporale degli Echinodermi dei fondi molli del Mar Tirreno Settentrionale nel triennio 1985-87. *Nova Thalassia*, 10 (suppl. 1): 603- 605.
4 - Pérès J. M., Picard J., 1964. Nouveau Manuel de Bionomie Benthique de la Mer Méditerranée. *Extrait du Recueil des Travaux de la Station Marine d'Endoume*, 31 (47): 1-137.

RECENT DATA IN THE HARD BOTTOM COMMUNITIES FROM THE ROMANIAN BLACK SEA COAST

Adrian Teaca [1], Tatiana Begun [1], Marian traian Gomoiu [1] and Victor Surugiu [2]*
[1] National Institute of Geology and GeoEcology – GeoEcoMar, Constanta Branch
[2] Universitatea Alexandru Ioan Cuza Iasi - vsurugiu@uaic.ro

Abstract
The authors present the qualitative and quantitative modifications of hard bottom associated fauna from the Romanian littoral, based on the analyses of 203 quantitative samples collected between 2001 - 2004. There were identified 152 taxa, with average density of 1,300,000 ind.m^{-2} and the average biomass of 17,000 g.m^{-2}. Comparing with '60-'70 period, the actual quantitative structure is five to ten times higher, while from qualitative point of view, the situation is still almost the same.
Keywords: Biodiversity, Zoobenthos, Rocky Shores, Black Sea

Introduction
The hard substratum from the Romanian littoral occupies a small area of about 70 km^2. Subsequently, the coastal works and protective dikes construction led to the increasing of areas with hard substratum and expansion of artificial epibiont system even more than that of natural one. The improper analysis of hard bottoms in the past have imposed a sporadic character of the studies, the latest known studies have been made in '60-'80 period [1, 2].

Material and methods
During the period 2001 - 2004, 203 quantitative samples of fauna from hard bottom have been collected from 10 stations distributed along the Romanian littoral, by means of SCUBA and free diving. In each station were taken quantitative samples from 3 depths (0, 1, 2 m). The vertical distribution of the benthic populations was analyzed based on samples collected from 9 depth intervals (0-16m) in Agigea area. The collecting method consisted in scraping of quadrate of 400 cm^2 surface (Fig.1).

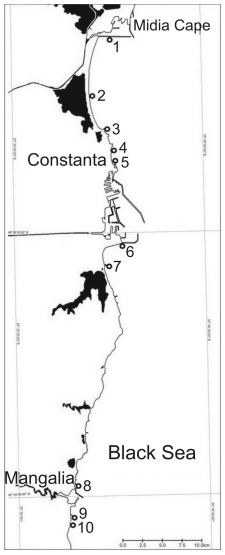


Fig. 1. Map of the investigated area with locations of sampling sites (Southern part of the Romanian Black Sea coast)

Results and discussions
The analyses of the samples helped identify 152 taxa (147 species). The polychaets (49 species) and the amphipods (21 species) were dominant in the qualitative structure with a share of 50 % of all found species. Qualitative structure of the taxonomic group is composed as follows: Porifera – 4 species, Cnidaria – 13, Turbellaria – 6, Nemertina – 4, Polychaeta – 49, Mollusca – 13, Halacaridae – 2, Bryozoa – 5, Crustacea – 50, Tunicata – 1 and non identified taxa/group - 5.
In the superior infralittoral (1 to 4m deep), 136 species were recorded, in the mediolittoral 89 taxa and 85 taxa in the infralittoral (6 to16 m deep).
Based on studies performed, it was concluded that the rock mussels' biocoenosis ranging between Cape Midia and Vama Veche, represents, in fact, a biocoenotic unity. Uniformity of structure and development are preserved in all analysed locations. The share of common species is about 85 % by abundance, due to 20 dominant species present in all locations.
According to depth the structure of rocky fauna varies significantly. The forming of associations in mediolittoral, having as dominant species the crustaceans *Hyale perieri*, *Echinogammarus olivii*, *Jaera nordmanni*, *Xestoleberis aurantia* and *Xestoleberis decipiens* is based on their affinity for the phytal substratum. The species grouping in the superior infralittoral based on coenotic affinities evinced the presence of an association numerically and as biomass dominated by *Melita palmata - Microdeutopus gryllotalpa - Amphitoe ramondi - Alitta succinea - Pilumnus hirtellus*. The dominant association in infralittoral is constituted within a nucleus of 4 species after density: *Melita palmata – Microdeutopus gryllotalpa - Jassa ocia - Stenothoe monoculoides* and 10 species after biomass: *Gonothyraea loveni, Alitta succinea, Platynereis dumerilii, Cryptosula pallasiana, Balanus improvisus, Melita palmata, Microdeutopus gryllotalpa, Jassa ocia, Athanas nitescens, Pisidia longicornis* (Bray-Curtis similarity) [3].
The trend of increase in the number of taxa with depth show biggest jump in the range 0 - 8 m of about 40 species from 0 m to 80 species at 8 m.
The average density was about 1,300 x 10^3 ind.m^{-2} and the average biomass was about 17 x 10^3 g.m^{-2}. The numerical dominants are represented by worms (580,000 ind.m^{-2}) and crustaceans (650,000 ind.m^{-2}) and as weight by molluscs (19,500 g.m^{-2}), crustaceans (215 g.m^{-2}) and worms (35 g.m^{-2}). Meiobental segment represents 87 % of the total average density while the biomass of macrobental forms over 99 %.
Relationship between numerical abundance and maximum weight of benthic fauna on natural hard bottoms and artificial hard bottom is 1 : 3 for density and 1 : 3.6 for average biomass.
Number of crustaceans species reported amounts to 50 (except the copepods) value that is superior to those cited in 1975 - 1995 period [2]. The current qualitative structure could be compared with that described for the Agigea rocky associations in 1961 [1].
The abundances are at least 5 to 10 times higher compared to those of '60s - '70s. The average density of 280 x 10^3 ind.m^{-2} from Agigea in `70 years have been much lower than in 2003 - 2004 period which was 1,300 x 10$^3$ ind.m$^{-2}$. Comparative analysis shows a profound destabilization of the population equilibrium, characterized by domination of worms by late of `80s (72 %) at the expense of other groups (Crustacea 17 %). The current state of benthos associated with hard substrate falls within the normal evolution (e.g. 38 % worms, Crustacea 54 %) compared with that of '60 period [1].
Taxa whose actual number reported in very low or none in previous years and which now form well contoured populations at Romanian seaside are *Opercularella lacerata* (F-25 %), *Ventromma halecioides* (F-30 %), *Tergipes tergipes* (F-50 %), *Ericthonius difformis* (F-40 %), *Jassa ocia* (F-50 %), *Siriella jaltensis* (F-20 %), *Athanas nitescens* (F-60 %), *Eriphia verrucosa*, *Palaemon adspersus* (F-20 %), *Pisidia longicornis* (F-70 %). Rare species with single occurrence cited as missing in recent years are *Limapontia capitata*, *Cymadusa crassicornis*, *Brachynotus sexdentatus*.

Acknowledgements
This work has been financially supported by the National Authority for Scientific Research (Grant PN-II-ID-PCE-2008-2/No. 116).

References
1 - Bacescu, M., Dumitrescu, E., Marcus, A., Paladian, G., Mayer, R., 1963. Donnees quantitatives sur la faune petricole de la Mer Noire a Agigea (secteur roumain) dans les conditions speciales de l'annee 1961. Trav.Mus.Hist.Nat. „Gr. Antipa" Vol IV, Bucuresti: 131-155
2 - Tiganus, V., 1981. Donnes quantitatives sur la faune petricole de petite profondeur du littoral roumain de la Mer Noire. *Rapp. Comm. Int. Mer.Medit.*, CIESM 27(2): 157-158.
3 - Teaca, A., 2006. Hard bottom biocoenosis in the shallow waters of the Romanian Black Sea littoral (Ph.D thesis).

QUALITATIVE AND QUANTITATIVE ASSESMENT OF THE MACROBENTHIC POPULATIONS OF CRUSTACEANS FROM THE NORTH - WESTERN PART OF THE BLACK SEA

Adrian Teaca [1], Tatiana Begun [1], Marian traian Gomoiu [1] and Victor Surugiu [2]*
[1] National Institute of Geology and GeoEcology – GeoEcoMar, Constanta Branch
[2] Universitatea Alexandru Ioan Cuza Iasi - vsurugiu@uaic.ro

Abstract
The paper presents the crustaceans' populations state in period 2003 - 2008. The total number of species was 66, approximately 60 % of the total number of species recorded in the NW Black Sea during the period 1960 - 1970. The most abundant crustacean was the opportunistic species *Ampelisca sarsi*.
Keywords: Crustacea, Zoobenthos, Black Sea

Introduction. Marine diversity is often a scope of environmental research especially within the framework of global environmental changes. The pontic crustaceans' fauna, although in small number of species, represent a complex group with a definitory importance in the benthic biocoenosis, from the limit of breaking waves zone to periazoic level. The state of any benthic community in the NW Black Sea region represents the "mirror" of ecological changes along the time, reflected in the "inventory" of the biota quality and quantity, published in the last 10 years in several papers [1, 2]. Nevertheless, researches referring to the crustaceans' population especially from the Romanian Continental shelf are very scarce.

Materials and Methods. In the period 2003 - 2008, a number of 437 quantitative benthos samples were collected between 0 – 213 m depths by means of the van Veen-type grab, box corer and multicorer. The offshore samples were collected during several cruises (R/V „Akademik" 2003, 2006, R/V „Parshin" 2005, R/V "Poseidon" 2008, R/V „Mare Nigrum" 2006, 2007 and 2008), while the inshore samples during several national projects covering only the sedimentary substrata. The sampling was done with 0.1 m^{-2} van Veen grab, or by 0.25m^{-2} box corer and 0.15 m^{-2} multicorer.

Results and Discussion. The analyses of the samples helped identify 66 species (Cirripedia - 1, Amphipoda – 35, Cumacea – 8, Mysida – 3, Tanaidacea – 2, Isopoda - 6 and Decapoda - 11), approximately 60 % of the total number of species recorded in the NW Black Sea and 65 % in the Romanian littoral zone during the period of "ecological prosperity" (Fig. 1). The mean abundance of the crustaceans' populations was 1,156.9 indv.m^{-2} for density and 5.78 g.m^{-2} for biomass. There are some differences in the spatial distribution of crustaceans in the NW Black Sea. The average density and biomass decrease as far as water depth decrease according to a logarithmic relation (Density - R^2 = 0.84; Biomass - R^2 = 0.93), from 1,806.5 ind.m^{-2} at 0-20 m depth, to 13.3 ind.m^{-2} at 111-130 m for density and 9.27 g.m^{-2} at 0.03 g.m^{-2} for biomass (Fig. 2)

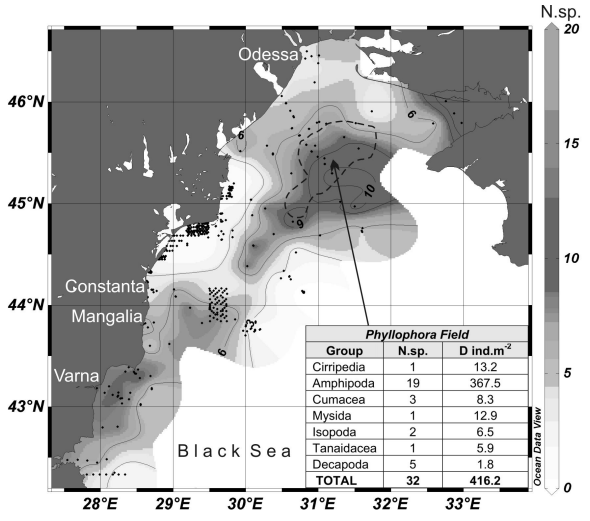


Fig. 1. The number of species of macrobenthic crustaceans' distribution in the NW Black Sea region

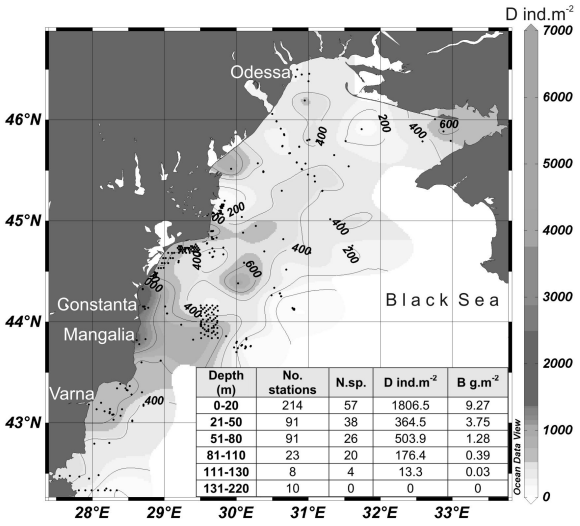


Fig. 2. The numerical abundance of macrobenthic crustaceans' distribution in the NW Black Sea region

The deep zone typical populations of crustaceans are stationated at 50 - 81 m deep. As the depth increases, the effectivenesses and the number of species decreases progressively. The dominant species in offshore zone are: *Ampelisca sarsi* (F-50 %), *Perioculodes longimanus* (F–46 %), *Phtisica marina* (F–44 %), *Apseudes acutifrons* (F–32 %), *Balanus improvisus* (F–32 %), *Apherusa bispinosa* (F–30 %), *Iphinoe elisae* (F–30 %), *Microdeutopus versiculatus* (F–29 %), *Caprella acanthifera* (F–27 %), *Corophium runcicorne* (F–25 %) and *Eudorella truncatula* (F–25 %). The populations from bathimetric interval 0 – 20 m are more heterogen realising the passage from littoral associations of sandy substratum to the muddy ones. The average density value recorded in the littoral zone exceeds 1,860 ind.m^{-2}, being four times higher than in the deep zone associations (455 ind.m^{-2}). These great values are explainable by the intercalation of two great biocoenotic associatons: faunistic association on the hard substratum and those from sedimentary substratum (implicit the spreading of hard substratum species in the structure of sedimentary associations) and also by the structure of littoral populations dominated in majority by the *A. sarsi* (F–55 %, 1,300 ind.m^{-2}), *B. improvisus* (F – 35 %) and *Iphinoe maeotica* (F-25 %). Zernov's *Phyllophora* Field became one of the most outstanding examples concerning the ecosystem degradation and biodiversity losses. The knowledge of the *Phyllopora* association state represents the key to the ecosystem recovery valuation. Without considering the modifications suffered, the maximum diversity of crustaceans (32 species) remains within the initial areal with Phyllophora due to habitats' variability (macrophytes, mussels clumps) (Fig. 1). Concluding, the observations made show a major restructuring of the existent populations through the great number of constant species, which dominate the benthic biocoenosis.

References
1 - Gomoiu M.-T., 1997. General data on the marine benthic populations state in the NW Black Sea in August 1995. *GEO-ECO-MARINA*, 2: 179 – 199
2 - Gomoiu M.-T., 2004. New approaches in the assessment of the Black Sea ecosystems. *GEO-ECO-MARINA* 9/10: 3 – 7

BIODIVERSITY PATTERNS OF DEEP-SEA BENTHIC MEGAFAUNA ON WESTERN AND CENTRAL MEDITERRANEAN BASINS

Samuele Tecchio [1]*, Eva Ramírez-llodra [1], Francisco Sardà [1] and Joan baptista Company [1]
[1] Institut de Ciències del Mar (CSIC) - tecchio@icm.csic.es

Abstract
Abundance, biomass and diversity patterns of bathyal and abyssal Mediterranean megafauna were analysed. Sampling was conducted with a bottom otter-trawl at depths ranging from 600 to 4000 m in the western Balearic Sea, the western Ionian Sea, and the eastern Ionian Sea. A general decline in diversity with depth along the three zones was found, while influence of geographic area was less marked.
Keywords: Biodiversity, Deep Sea Ecology, Western Mediterranean, Ionian Sea

The Mediterranean deep-sea environment is an optimal natural laboratory to study ecological processes. Commercial trawling reaches depths of 900 m maximum, allowing for studies of non-impacted environments below this depth. Knowledge of benthic megafaunal diversity and its patterns of variation between basins is at present very scarce.

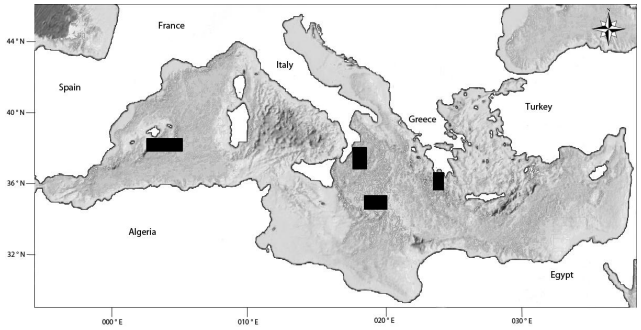


Fig. 1. Map of Mediterranean Sea, with sampled areas indicated

Megafaunal samples were collected in 26 OTMS trawls between 600 and 4000 m during a trans-Mediterranean cruise (June 2001, Fig. 1). The western Balearic basin, the western Ionian sea and the eastern Ionian sea were investigated. The megafauna was identified to species level, counted and wet weighted (± 1 g). A faunal list was compiled, indicating occurrence of each species in each zone. Species richness, Shannon-Wiener H', Margalef's diversity and Pielou's evenness indexes were calculated for each sample. Similarity of community structure amongst samples from all geographic areas and depths was visualised with a non-metric multidimensional scaling (MDS). Two-way similarity percentages (SIMPER) statistical routine was conducted, using "depth" and "basin" as crossed factors and Bray-Curtis measure as similarity [2].

The most speciose groups were Actinopterygii (45% of species), crustaceans (32.4% of species) and Chondrichthyes (7.8% of species). Across the whole dataset, Margalef species richness index shows a significant decrease with depth and negative linear correlations between species richness and depth were found for each of the three zones considered separately. Pielou's index increased with depth in the western Balearic basin, with an abrupt decrease at 1230 m caused by the abundance peak of the fish *Alepocephalus rostratus* in the western Balearic. A similar pattern was present in the western Ionian, with a decrease of the index at 1500 and 1700 m caused by the spiderfish *Bathypterois dubius*. The biology of this species is more adapted to the scarce trophic resources, although the exact reasons for this dominance of *B. dubius* are, at present, not described. Species evenness at the two abyssal depths was low compared to the rest of the western Ionian basin. In the eastern Ionian Sea, the evenness index showed an inverted V-shape pattern. Shannon-Wiener index, along with standardized biomass, are shown in Fig. 2.

According to SIMPER analysis, dissimilarity in community composition between the western Balearic basin, the western Ionian and the eastern Ionian, across all depth ranges, is mainly caused by the fishes *A. rostratus* and *C. mediterraneus*, the shark *C. coelolepis* and the decapods *A. antennatus*, *P. typhlops*, and *G. longipes*. The MDS showed a clear depth zonation. The trawls at 600-800 m grouped together, confirming the *middle slope* subdivision [3]. The depth range 1000-1700 m showed the higher dispersion between trawls, as previously reported for fishes and crustacean assemblages in the Mediterranean. The deepest assemblages at 1700-3000 m, along with the two trawls conducted at 3300 m and 4000 m in the central Ionian abyssal plain, grouped together, suggesting that below 1500 m there are no major changes in assemblages structure with depth. The three zones exhibited a comparable species richness down to 1500 m depth, but after this limit only the western Balearic basin maintained a Margalef index of above 2.0, while in the Ionian basins (both western and eastern) values decreased rapidly. We suggest that higher surface productivity and coastal input of the western Balearic basin supply the necessary energy to sustain a diverse community at lower depths in this zone. In the more oligotrophic Ionian Sea, organic matter arrival to the lower slope and deep basin is reduced, forcing a decrease in diversity earlier in the depth range.

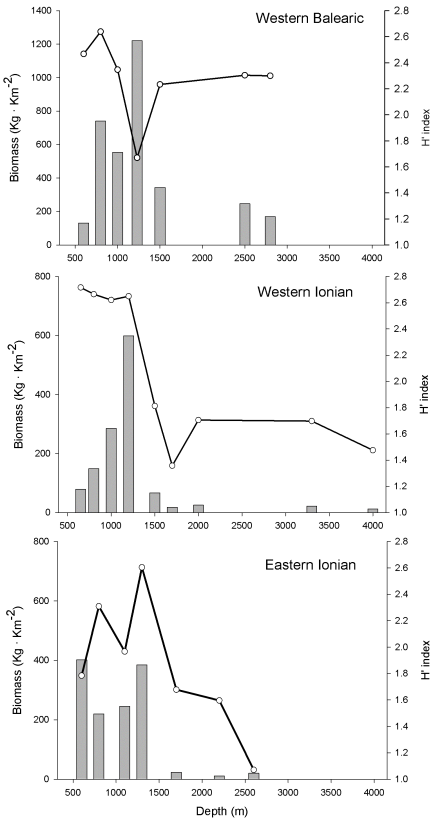


Fig. 2. Standardized biomass (gray bars) and values of Shannon diversity index (lines) for the three studied areas

References
1 - Sardà, F., et al., eds., 2004. Mediterranean deep-sea biology. *Sci. Mar*. 68(3). 204 pp.
2 - Clarke, K.R. and R.M. Warwick, *Change in marine communities: an approach to statistical analysis and interpretation*. 2001: PRIMER-E Ltd., Plymouth, UK.
3 - Pérès, J.M., *History of the Mediterranean biota and colonization of the depths*, in *Western Mediterranean*, R. Margalef, Editor. 1985, Pergamon Press, Oxford. p. 198-232.

OSMOTIC STRESS EFFECTS ON THE BIOCHEMICAL COMPOSITION OF THE DIGESTIVE GLAND OF THE SCALLOP *FLEXOPECTEN GLABER*

K. Telahigue [1]*, I. Rabeh [1], I. Chetoui [1], N. Ghazali [1], D. Boussoufa [1], M. S. Romdhane [2] and M. El Cafsi [1]
[1] Faculté des sciences de Tunis - k_telahigue@yahoo.fr
[2] Institut National Agronomique de Tunisie

Abstract
This study refers to the biochemical composition of the digestive gland of *Flexopecten glaber*. Results show that the hyposmotic and the hyper-osmotic stress induce a decrease in the total content of glycogen and lipids. The osmotic stress induces an increase of the polyunsaturated fatty acids and the (*n*-3) group; mainly the C18:3*n*-3 and C18:4*n*-3. Conversely the EPA (C20:5*n*-3) decreases as a response to any variation of salinity around the optimal salinity rate (35 psu).
Keywords: Bivalves, Physiology, Aquaculture

Introduction
The digestive gland plays an important role in the physiology of the mollusk bivalves. This organ is mainly involved in the storage of lipids and glycogen ([1], [2], [3]). In this study we investigated the effects of salinity variation on the biochemical composition (glycogen, lipids and fatty acids) of the digestive gland of the scallop *F.glaber*.

Material and Methods
Individuals of *F.glaber* were acclimated for 3 weeks under constant temperature (15°C) and different salinity rates (25, 30, 35 and 40 psu). Scallops were fed a monoalgal diet based on *Isochrysis galbana*. The total glycogen was analyzed according to the enzymatic method [4]. Total lipids were extracted according to Folch et al. method [5]. Fatty acid methyl esters were obtained according to [6] and analyzed on a HP 6890 gas chromatograph. Statistical analyses were carried out using the software-program Statistica 6.0. Data were analyzed for significant differences of means, ANOVA, and inspected by Duncan test at the level of 5%.

Results and Discussion
Results showed that total glycogen and lipids contents of the digestive gland decrease significantly mainly at 25 psu (2.66 mg/g and 60 mg/g respectively) and 40 psu (2.22 mg/g and 64mg/g respectively) in comparison with the optimal salinity of 35 psu (3.95 mg/g and 81mg/g respectively). Concerning fatty acids, we noted that the elevation (40 psu) and diminution (25 psu and 30 psu) of salinity induce an increase of the åPUFA (Polyunsaturated fatty acids) as well as the åMUFA (Monounsaturated fatty acids) and a decrease of the åSFA (Saturated fatty acids) compared to the control salinity (35 psu). We also noted an elevation of the å(*n*-3) and å(*n*-6) under hyposmotic and hyperosmotic stress. We recorded that the osmotic stress induces an increase of the C18:3*n*-3 (from 0.7% at 35 psu to 6.25% at 30 psu and 4.66% at 25 psu) and the C18:4*n*-3 (from 2.24% at 35psu to 12.59% at 40 psu and 10.45% at 30 psu). Conversely we noted a significant diminution of the EPA (C20:5*n*-3) from 7.08% at 35psu to 3.42% at 40 psu and 3.48% at 25 psu. Recorded results are linked with the role played by the PUFA (mainly *n*-3) in the regulation of permeability and fluidity of the membrane; specially the EPA which may serve as a substrate for prostaglandin biosynthesis as a stress response [7].

References
1 - Strohmeiers T., Duinker A., and Lie O., 2000. Seasonal variations in chemical composition of female gonad and storage organs in *Pecten maximus* (L.) suggesting that somatic and reproductive growth are separated in time. *J. Shellfish Res*., 19: 741-747.
2 - Le Pennec G., Le Pennec M., and Beninger P.G., 2001. Seasonal digestive gland dynamics of the scallop *Pecten maximus* in the bay of Brest (France). *J. Mar. Biol. Assoc. UK.*, 81: 663–671.
3 - Pazos A.J., Sanchez J.L., Roman G., Pérez-Prallé M.L., and Abad, M., 2003. Seasonal changes in lipid classes and fatty acid composition in the digestive gland of *Pecten maximus*. *Comp. Biochem. Physiol. Part B.*, 134: 367–380.
4 - Dubois M., Gilles K.A., Hamilton J.K., Rebers P.A., and Smith F., 1956. Colorimetric method for determination of sugars and related substances. *Anal. Chem*., 28: 350–356.
5 - Folch J., Less M., and Sloane-Stanley C.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem*., 266 : 497–509.
6 - Cecchi G., Basini S., and Castano C., 1985. Méthanolyse rapide des huiles en solvant. *Revue française des corps gras* n4.
7 - Hall J.M., Parrish C.C., and Thompson R.J., 2002. Eicosapentaenoic acid regulates scallop (Placopecten magellanicus) membrane fluidity in response to cold. *Biol. Bull*., 202:201–203.

COMPARATIVE FATTY ACIDS PROFILES OF *FLEXOPECTEN GLABER* DIGESTIVE GLAND UNDER STARVATION AND MONOALGAL DIET CONDITIONS

K. Telahigue [1]*, I. Chetoui [1], I. Rabeh [1], M. S. Romdhane [2] and M. El Cafsi [1]
[1] Faculté des sciences de Tunis - k_telahigue@yahoo.fr
[2] Institut National Agronomique de Tunisie

Abstract
The starvation effects on the fatty acids composition of the digestive gland of the scallop *Flexopecten glaber* were underwent in this study. Results show that food deprivation induces a diminution of the amounts of the EPA (C20:5*n*-3) and the DHA (C22:6*n*-3) as well as the *n*-3/*n*-6 ratio. Meanwhile, a selective retention, in terms of increase of percentage, of the AA (C20:4*n*-6) in unfed specimens is recorded.
Keywords: Aquaculture, Bivalves, Physiology

Introduction
In scallops, the digestive gland is the most important organ involved in lipids reserve storage [1, 2]. The fatty acids composition of the digestive gland essentially depend on the food availability [3]. In this study we compared the fatty acids profile of the digestive gland of *Flexopecten glaber* under two nutritional conditions to asses the effects of the food deprivation on fatty acids composition of this organ.

Materiel and Methods
Tow groups of 6 individuals of *F. glaber* were acclimated for 3 weeks at constant temperature (15°C) and salinity (35 psu). The first lot was fed a monoalgal diet based on *Isochrysis galbana*; whereas the second group was starving. Total lipids were extracted according to the Folch method [4]. Fatty acid methyl esters were obtained according to [5] and analyzed by a HP 6890 gas chromatograph. Statistical analyses were carried out using the software-program Statistica 6.0. Data were analyzed for significant differences of means and inspected by Duncan test at the level of 5%.

Results and discussion
Results, reported on the table 1, show that under food deprivation the Saturated Fatty Acids decrease in general; the most pertinent diminutions concern, however, the Myristic acid (C14:0), the Palmitic acid (C16:0) and the Stearic acid (C18:0). Also, under the same starvation condition, a significant decrease of the *n-3* polyunsaturated fatty acids is recorded (from 23.45% in the fed lot to 7.52% in the unfed lot). Oppositely, an elevation of the *n*-6 polyunsaturated fatty acids is observed (from 4% to 19.42% respectively). Consequently, the deprivation effect is the decrease of the *n*-3/*n*-6 ratio. Within the Polyunsaturated Fatty Acids decrease trend, the most important starvation effects are observed for EPA (C20:5*n*-3) and DHA (C22:6*n*-3) amounts. Contradictory, the amount of AA (C20:4*n*-6) is maintained at significantly higher level. This phenomenon of selective retention of the ALA, which is involved in the prostaglandin synthesis [6], would correspond to a survival strategy and a mean to stand starvation stress adopted by the mollusk. Similar results were recorded in neutral lipids of starved mussels [7].

Tab. 1. Fatty acids percentages in the digestive gland of *F. glaber* starving and fed on monalgal diet conditions. ΣSFA: total saturated fatty acids; ΣMUFA: total monounsaturated fatty acids; ΣPUFA: total polyunsaturated fatty acids

Fatty acids	Digestive gland	
	Starving	Fed
	Mean ±S.D	Mean ±S.D
C14:0	3.46±0.14	7.19±0.28
C14:1	0.81±0.09	0.40±0.01
C15:0	2.57±0.17	1.89±0.01
C15:1	2.09±0.26	1.01±0.04
C16:0	3.67±0.34	19.16±0.82
C16:1n-9	0.31±0.03	2.54±0.03
C16:2	0.33±0.05	0.57±0.02
C17:0	0.28±0.03	0.56±0.01
C16:3	0.88±0.21	1.31±0.01
C16:4	1.14±0.12	1.81±0.01
C18:0	1.23±0.16	18.47±0.47
C18:1*n*-9	0.40±0.06	2.18±0.18
C18:1*n*-7	-	1.80±0.02
C18:2*n*-6	0.34±0.04	0.64±0.01
C18:3*n*-3	0.20±0.04	0.70±0.01
C18:4*n*-3	0.20±0.03	2.24±0.08
C20:0	0.13±0.03	1.27±0.18
C20:1	0.10±0.01	1.24±0.12
C20:2*n*-6	0.20±0.02	0.15±0.11
C20:3*n*-6	0.49±0.06	0.62±0.29
C20:4*n*-6	3.85±0.41	1.82±0.37
C20:3*n*-3	0.20±0.01	0.22±0.04
C20:4*n*-3	0.38±0.03	3.00±0.23
C20:5*n*-3	0.40±0.04	7.08±0.25
C22:0	0.34±0.02	0.40±0.11
C22:1	0.54±0.07	-
C21:5	0.32±0.12	0.23±0.02
C22:2*n*-6	0.08±0.03	0.18±0.08
C22:3*n*-3	0.15±0.10	0.73±0.13
C22:5*n*-3	0.13±0.04	0.29±0.03
C22:6*n*-3	0.28±0.11	5.78±0.75
∑SFA	45.90±1.55	57.26±2.16
∑MUFA	16.68±0.26	10.72±0.25
∑PUFA	37.42±1.37	32.02±1.91
∑*n*-3	7.52±0.76	23.45±1.77
∑n-6	19.42±0.23	4.00±0.13
n-3/*n*-6	0.39±0.03	5.86±0.25

References
1 - Le Pennec G., Le Pennec M., and Beninger P., 2001. Seasonal digestive gland dynamics of the scallop *Pecten maximus* in the Bay of Brest (France). *J. Mar. Biol. Assoc. UK*., 81 (4): 663-671.
2 - Pazos A. J., Sanchez J. L., Roman G., Pérez-Prallé M. L., and Abad M., 2003. Seasonal changes in lipid classes and fatty acid composition in the digestive gland of *Pecten maximus*. *Comp. Biochem. Physiol*., 134 B: 367–380.
3 - Silina A. V., and Zhukova N. V., 2007. Growth variability and feeding of scallop *Patinopecten yessoensis* on different bottom sediments: evidence from fatty acid analysis. *J. Exp. Mar. Biol. Ecol*., 348: 46–59.
4 - Folch J., Less M., and Sloane-Stanley C.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem*., 266: 497–509.
5 - Cecchi G., Basini S., and Castano C., 1985. Méthanolyse rapide des huiles en solvant. *Revue française des corps gras* n4.
6 - Nomura T., Ogata H., and Lucas A., 1979. Mise en évidences des prostanglandines chez les mollusques bivalves. *Rev. Int. Océanogr. Med.*, 53/54: 87–94.
7 - Pirini M., Manuzzi M.P., Pagliarani A., Trombetti F., Borgatti A.R., and Ventrella V., 2007. Changes in fatty acid composition of *Mytilus galloprovincialis* (Lmk) fed on microalgal and wheat germ diets. *Comp. Biochem. Physiol*., 147B: 616–626.

MAY THE IDEA OF PARTITIONING THE PELAGOS SANCTUARY IN AREAS OF SPECIFIC INTERESTS SOLVE THE PROBLEM OF HOW TO PROTECT 100,000KM2? THE SPERM WHALE CASE

Paola Tepsich [1]*, Massimiliano Rosso [1], Maurizio Wurtz [2] and Aurelie Moulins [1]
[1] CIMA Research Foundation - paola.tepsich@cimafoundation.org
[2] Dipartimento di biologia - Università di Genova

Abstract
The 2009 acoustic "scan" realized inside the Pelagos Sanctuary aimed to get information on the sperm whale distribution. Results indicate some aggregations and specifically close to hotspots determined by a previous study. This information can be used to concentrate mitigation effort needed for Pelagos Sanctuary's efficiency.
Keywords: Deep Waters, Cetacea, Ligurian Sea

Introduction
The establishment of the Pelagos Sanctuary is the first step that aims to focalize on the necessity to protect the cetacean and their ecosystem. However, its efficiency depends totally on the proposed mitigation instruments and on our knowledge of the different cetacean populations inhabiting the area. Indeed, the northwestern area being extensively used by maritime transport, fisheries, militaries as well as the coast, conflicts of interests slow down the processes of protection. At the same time, 8 species of cetaceans are considered as commonly seen in the Pelagos Sanctuary and the area is used differently by each one of them [1]. A possible alternative is to partition the Pelagos area in particular specific areas where one specific risk has to be solved for a specific species. Based on the 2009 "scan" realized for the ISHMAEL project inside the Pelagos Sanctuary, the study discusses the obtained sperm whale distribution according to hotspots previously characterized.

Material and methods
In 2009, a large "scan" of the Pelagos Sanctuary was realized by two vessels: *Menkab*, the research boat of the *Biology Department* of the *University of Genoa* and *Halifax*, the sailing boat of the NGO *Participe Futur*. The "scan" focuses on the area encompassed by the 500m and 2500m isobaths organized in 597 acoustic stations. On each station, we use an omni-directional hydrophones (with a range of about 3 NM from the station) to detect sperm whales. In some cases after the positive detection on *Menkab*, it has been decide to localize the animal with a prototype 3-D hydrophone in order to test the capacity to find the animal and continue eventually with photo-id protocol. Visual detection was also performed between the acoustic stations with 4 trained observers watching the 360° around the boat.

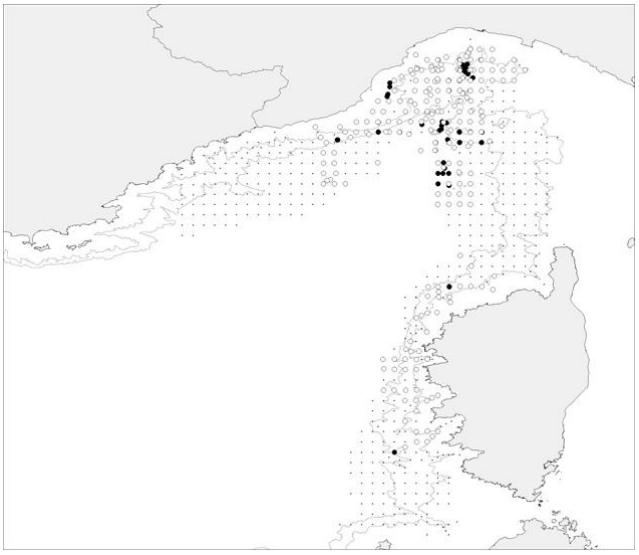


Fig. 1. Distribution of the initial 597 acoustic stations (small dots), 294 have been checked (white dots), 42 resulted positive to sperm whale presence (black dots). Isobaths of 1000m and 2000m are represented

Results and discussion
During 2009, about 294 acoustic stations where performed: 52 by *Halifax* in 18 days and 242 by *Menkab* in 23 days; however, only 189 were performed on the 597 initial positions. In total, 42 were positive with sperm whales; 14 amongst postive stations are considered to detect different individuals (12 stations in the northern part of the sanctuary and 2 off Corsica; fig. 1). The probability to hear sperm whale is 0.06. The estimated number of animals encountered is 17 whales while 8 have been sighted. According to the 4 hotspot obtained by [2], 4 of the 12 stations of the northern part of the Pelagos Sanctuary are inside or close three of the hotspots. This result seems to confirm that specific areas are inhabited repeatedly by the species and thus this information can be used to design areas with major attention.

Acknowledgements: ISHMAEL project is fund by *Fondation TOTAL*. We also thanks *Participe Futur* for their participation to the project and in particular all the eco-volunteers.

References
1 - Azzellino, A., Gaspari, S., Airoldi; S. and Nani, B., 2008. Habitat use and preferences of cetaceans along the continental slope and the adjacent pelagic waters in the western ligurian sea. *Deep-Sea Res. I*, 55: 296-323.
2 - Moulins A., Ballardini M., Rosso m. and Würtz M., 2008. Partition of the Pelagos Sanctuary (north-western Mediterranean Sea) into hotspots and coldspots for cetacean sightings. *J. Mar. Biol. Ass. U.K.*, 88(6): 1273-1281.

CHANGES IN MESOZOOPLANKTON ABUNDANCE, BIOMASS AND SPECIES COMPOSITION WITH DEPTH IN THE LEVANTINE BASIN (EASTERN MEDITERRANEAN)

T. Terbiyik [1]*, Y. Ak-Orek [2], A. Gubanova [3], Z. Uysal [2] and S. Polat [1]
[1] Cukurova University Faculty of Fisheries, Department of Marine sciences, 01330 Balcali,Adana,Turkey - tterbiyik@cu.edu.tr
[2] METU, Institute of Marine Sciences P.O Box:28 33731, Erdemli,Mersin, Turkey
[3] Plankton Department, Institute of Biology of the Southern Seas, 2, Nakhimov ave, 99011 Sevastopol, Ukraine

Abstract
Species composition, abundance and biomass distribution of mesozooplankton species with depth were studied in the Levantine basin (eastern Mediterranean) within the framework of SESAME (Southern European Seas: Assessing and Modelling Ecosystem changes). Copepods were found to be the dominant group at all depth layers sampled during both sampling periods. Mesozooplankton biomass and abundance varied between 2.2-18.1 mgm^{-3}, 72.28-757.55 ind.m^{-3} in April 2008 and 0.98-4.67 mgm^{-3} and 99.54-492.52 ind.m^{-3} in October 2008, respectively. Mesozooplankton biomass and abundance tend to decrease with depth.
Keywords: Levantine Basin, Biomass, Zooplankton , Eastern Mediterranean

Introduction
Mediterranean and particularly the eastern Mediterranean is considered to be one of the extreme oligotrophic regions in the world, in terms of both primary productivity and chlorophyll *a* concentrations (1). Zooplankton form an important link in the pelagic food web due to the transfer of energy from unicellular algae to higher trophic levels (2). Studying zooplankton communities are especially crucial for not only detecting ecological changes and understanding the functioning of pelagic ecosystems, but also in terms of fisheries. The aim of this study was to determine the vertical distribution of mesozooplankton biomass & abundance and species composition in the oligotrophic Levantine basin.

Material and methods
Mesozooplankton samples were collected from standard layers (0–50, 50–100, 100–200 m), with the aid of a WP2 closing net of 200 µm mesh size during daytime (06:00-18:00) from the Levantine basin (Fig.1) in April and October 2008. All samples were split into two halves for the estimation of biomass (dry weight) in one and
for species identification in the other.

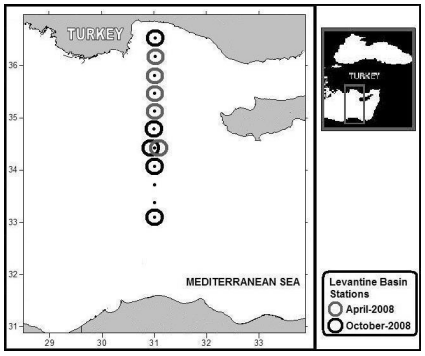


Fig. 1. Location of the sampling stations in the Levantine Basin

Results and Discussion
A total of 145 taxa were identified from the basin. Copepods were found as the dominant group at all layers during both sampling periods. In April 2008, copepods and siphonophorans were generally more abundant in the layer 0-50m (except E30N00), whereas, doliloida and appendicularians in layers 0-50 and 50-100 m, ostracoda in layers 50-100 and 100-200 m were found more abundant. In April, *Calocalanus styliremis, Clausocalanus jobei, C. parapergens, C. paululus, Lucicutia flavicornis, Mecynocera clausi, Paracalanus dunudatus, P. nanus, Farranula rostrata, Oithona plumifera, O. setigera,* Oncea media groups, *Oncea mediterranea* dominated the top 50 m whereas *C. contractus, Ctenocalanus vanus, Haloptilus longicornis, L. flavicornis, M. clausi, P. denudatus, P. nanus, F. rostrata, O setigera,* Oncea media groups became dominant in the layer 50-100 m. Finally copepod species namely *H. longicornis, O. setigera, Mormonilla minor* and *O. mediterranea* dominated the layer 100-200 m . In October 2008, copepods, chaetognaths, siphonophorans and cladocerans were more abundant in the layer 0-50 m , while Ostracoda was found higher in the 50-100 m depth range. Appendicularians were more abundant in the layers 0-50 and 50-100 m. In general, *Clausocalanus furcatus, C. paululus, C.pavoninus,O. plumifera* in the layer 0-50 m., *C.contractus, C styliremis ,C. pavo, C. jobei, O. setigera, F. rostrata* in the layer 50-100 m and *C. paululus, H. longicornis, M. clausi, P. denudatus, O. setigera, M. minor* in the layer 100-200 m were found abundant copepod species. Changes in mesozooplankton biomass and abundance at stations during April & October 2008 are shown in fig2. In April 2008, mesozooplankton biomass and abundance varied from 2.20 mg m^{-3} (F50N00, 100-200 m) to 18.10 mg m^{-3} (E30N00, 50-100 m) and from 72.28 ind (G10N00, 100-200m) to 757.55 ind m^{-3} (E30N00, 50-100 m), respectively. Mesozooplankton biomass and abundance in October 2008 found to vary from 0.98 mg m^{-3}, 99.54 ind m^{-3} (E30N00, 100-200 m) to 4.67 mg m^{-3}, 492.52 ind m^{-3} (E10N00, 0-50 m), respectively. Mesozooplankton was more abundant in April than in October and both biomass and abundance values tend
to decrease with depth.

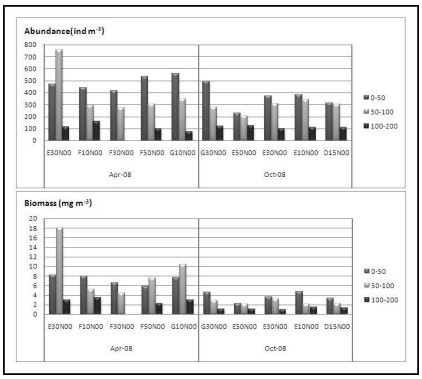


Fig. 2. Changes in mesozooplankton biomass and abundance in all sampling stations

Acknowledgements Present study was carried out in the northern Levantine basin within the framework of SESAME. Thanks are also due to academic and technical staff of the Institute of Marine Sciences of METU.

References
1 - Azov, Y., 1986. Seasonal patterns of phytoplankton productivity and abundance in near-shore oligotrophic waters of the Levant Basin (Mediterranean). *Journal of Plankton Research* 8: 41–53.
2 - Lenz, J., 2000. Introduction, In: , (Harris, R.P., Wiebe, P., Lenz, J., Skjoldal, H.R., Huntley, M. (eds.), Zooplankton Methodology Manual. *Academic Press,*, 1-32.

A PRELIMINARY STUDY ON THE MACROZOOBENTHIC INVERTEBRATE FAUNA OF TWO BANKS IN THE NORTH AEGEAN SEA

Bülent Topaloglu [1]*, Bayram Ozturk [1], Eda n. Topçu [1] and Onur Gönülal [1]
[1] Istanbul University,Fisheries Faculty & Turkish Marine Research Foundation - topalbl@istanbul.edu.tr

Abstract
In this study, two high sea banks on the North Aegean Sea were sampled. The Johnston Bank has 41 m. depths with coralligenous habitat and The Sinaya Bank has 130 m. depths with mud-sandy habitat. Totally 2288 individuals belonging to 51 taxa in Johnston Bank and 490 individuals belonging to 17 taxa in Sinaya Bank were sampled. We assume that The Johnston Bank is an important spawning ground for many benthic species and needs protection.
Keywords: Aegean Sea, Zoobenthos, Eastern Mediterranean

Introduction
Benthic studies in the North Aegean Sea are mostly on communities and species check-list [1], [2], [3]. The Aegean Sea has several banks what makes it very important for benthic biodiversity. However, the studies on these banks are limited. The characteristics of the benthos of Bruker, Mansell and Stocks banks were comparatively studied [4] and the most complicated trophic structure was found at the Stocks bank whereas the simplest one was near the Lesbos Island. A recent study was conductedon the habitat structure and biological characteristics of a maerl bed off the northeastern coast of the Maltese Islands [5]. Two stations were monitored to study temporal variation in species diversity. The maerl bed proved to have high species diversity with 244 animal and 87 algal taxa recorded; *Bittium latrelli* was the dominant taxa.

Material and Methods
Two high sea banks were studied at the North Aegean Sea. The Sta.1 is known as Johnston Bank at 41 m depth surrounded by depths of 200-500 m. The Sta.2 is known as Sinaya Bank at 130 m surrounded by depths of 200-300 m (See Map.1). The samples were taken by dredge with 2 knot speed during 10 minutes at the end of November 2008. The water temperature, salinity and dissolved oxygen were measured by SeaCat 19plus CTD profiler. The samples were counted, identified and fixed.

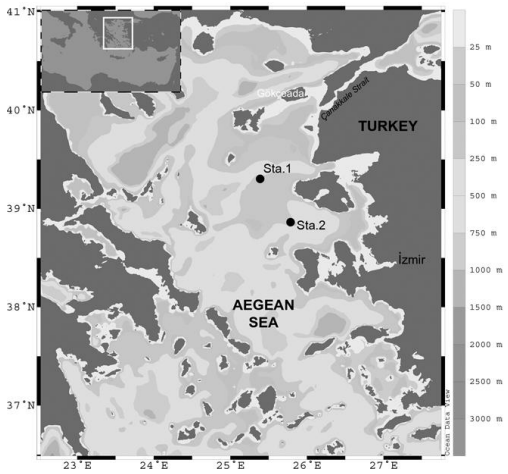


Fig. 1. Map of the sampling stations (revised from http://odv.awi.de)

Results and Discussion
Totally 51 taxa were sampled at the Sta. 1 and 17 taxa at Sta.2. At the Sta.1, *Gammarus locusta* was the most dominant species with 26,75 % followed by *Bittium latrelli* with 24,56 %. At the Sta.2, *Parapenaeus longirostris* was the most dominant species with 69,39 % (See Table 1.). Water temperature was measured as 16,55 °C at the Sta.1 and 16,27 °C at the Sta. 2. The salinity was 39,2 ‰ and dissolved oxygen was 6,5 mg/l at the both stations. According to the results, the oceanographic conditions were almost similar at Sta.1 and Sta.2 but the main differences are depth and habitat structure. The main habitat of Sta.1 is coralligenous with 41 m. whereas it is sand-mud in Sta.2 with 130 m. The dominant species at the Sta.2 (*P. longirostris*) is consistent with [3], and that of Sta.1 (*B. latrelli*) is coherent with [5]. Beside this, the number of collected individuals is 2288 belonging to 51 taxa at the Sta.1 and 490 belonging to 17 taxa at the Sta. 2. Many of the individuals at the Sta.1 were observed in juvenile stage. Coralligenous habitats are important in terms of marine biodiversity and an action plan for these habitats in the Mediterranean Sea was prepared by RAC/SPA [6]. These high sea banks should be protected from the bottom trawling and similar harmful fishing activities. We assume that Johnston Bank could be set as a marine protected area as it is an important spawning ground in the Northern Aegean Sea and a coralligenous habitat. More detailed studies are needed in the high sea part of the Aegean Sea.

Tab. 1. Number of individual (i.nm.) and dominance (D%) in the stations

STATION 1 Jhonston Bank 41 m. depth Coralligenous Habitat					
taxon	i.nm.	D(%)	taxon	i.nm.	D(%)
CRUSTACEA			MOLLUSCA		
Achaeus cranchii	1	0,04	*Arca tetragonata*	27	1,18
Alpheus ruber	2	0,09	*Bittium latrelli*	562	24,56
Anapagurus sp.	140	6,12	*Bolma rugosa*	14	0,61
Dromia sp.	1	0,04	*Bulla striata*	1	0,04
Ebalia sp.	27	1,18	*Calliostoma granulatum*	7	0,31
Eurynome aspera	1	0,04	*Calliostoma zizyphinum*	74	3,23
Galathea intermedia	13	0,57	*Calyptera chinensis*	9	2,53
Gammarus locusta	612	26,75	*Chiton corallinus*	1	0,04
Inachus dorsettensis	9	0,39	*Chiton olivaceus*	58	2,54
Inachus sp.	4	0,17	*Chlamys varia*	8	0,35
Liocarcinus corrugatus	4	0,17	*Clanculus corallinus*	5	0,22
Liocarcinus pusillus	1	0,04	*Diadora gibberula*	3	0,13
Lissa chiragra	25	1,09	*Erata voluta*	7	0,31
Macropodia rostrata	10	0,44	*Hitella sp.*	39	1,71
Majidae sp.	1	0,04	*Jujubinus striatus*	4	0,17
Munida rugosa	235	10,27	*Lucinella divaricata*	1	0,04
Nepinnotheres pinnotheres	1	0,04	*Modiola phaseolina*	35	1,53
Parthenope massena	10	0,44	*Trophonopsis muricatus*	22	0,96
Philocheros sp.	11	0,48	*Vexillum ebenus*	2	0,09
Pisa armata	10	0,44	*Vexillum tricolor*	2	0,09
Processa sp.	16	0,7	ECHINODERMATA		
Scyllarus arctus	2	0,09	*Asterina gibbosa*	1	0,04
Sphaeroma serratum	3	0,13	*Brissopsis mediterranea*	3	0,13
Xantho cf. granulicarpus	1	0,04	*Cidaris cidaris*	31	1,35
Xantho cf. pilipes	3	0,13	*Echinaster sepositus*	5	0,22
NEMERTINA			*Echinus melo*	119	5,2
Polychaeta(sp.)	105	4,59	TOTAL	2288	
STATION 2 Sinaya Bank 130 m. depth Sand-Mud Habitat					
taxon	i.nm.	D(%)	taxon	i.nm.	D(%)
CRUSTACEA			ECHINODERMATA		
Dardanus arrosor	1	0,2	*Antedon mediterranea*	1	0,2
Liocarcinus depurator	39	7,96	*Astropecten sp.*	21	4,29
Parapenaeus longirostris	340	69,39	*Stichopus regalis*	2	0,41
Pontocaris calaphractus	1	0,2	MOLLUSCA		
Squilla mantis	16	3,26	*Illex coindetii*	34	6,94
CNIDARIA			*Octopus sp.*	1	0,2
Actinia equina	5	1,02	*Octopus vulgaris*	9	1,84
Ascidiacea (sp.)	2	0,41	*Rondeletiola minor*	4	0,82
Pennatula sp.	1	0,2	*Sepia officinalis*	12	2,45
			Sepia orbignyana	1	0,2
			TOTAL	490	

References
1 - Koukouras, A., Dounas, C., Türkay, M., Voultsiadou-Koukoura, E., 1992. Decapod Crustacean Fauna of the Aegean Sea: New Information, Check List, Affinities. Senckenbergiana Marit. 22 (3/6): pp:217-244.
2 - Morri, C., Bianchi, C.N., Cocito, S., Peirano, A., De Biase, A.M., Aliani, S., Pansini, M., Boyer, M., Ferdeghini, F., Pestarino, M. and Dando, P., 1999. Biodiversity of marine sessile epifauna at an Aegean island subject to hydrothermal activity: Milos, eastern Mediterranean Sea, *Marine Biology*, 135: 729-739.
3 - Topaloglu,B., 2007. Investigation on the Macrozoobentic invertebrate fauna in the North Aegean sea. Rapp.Comm. Int. Mer Medit. 38: 618.
4 - Kiseleva, M.I., 1983. Comparative Characteristics of the Benthos at Some Banks in the Aegean Sea. Thallasographics. (6): 107-118.
5 - Sciberras, M., Rizzo, M., Mifsud, J.R., Camilleri, K., Borg, J.A., Lanfranco, E. and Schembri, P.J., 2009. Habitat structure and biological characteristics of a maerl bed off the northeastern coast of the Maltese Islands (central Mediterranean). *Mar Biodiv*. DOI 10.1007/s12526-009-0017-4.
6 - UNEP-MAP-RAC/SPA., 2008. Action plan for the conservation of the coralligenous and other calcareous bio-concretions in the Mediterranean Sea. Ed. RAC/SPA,Tunis : 21 pp.

EXPLOITATION PATTERN OF THE MEDITERRANEAN FISHERIES

Athanassios c. Tsikliras [1]*, Anny Dinouli [1] and Konstantinos i. Stergiou [2]
[1] Department of Ichthyology and Aquatic Environment, University of Thessaly, Volos, Greece - tsikliras@uth.gr
[2] Laboratory of Ichthyology, Department of Zoology, Aristotle University of Thessaloniki, Thessaloniki, Greece

Abstract
The annual landings of the Mediterranean fisheries were analysed for the period 1970-2005 and classified into exploitation categories based on the shape of the catch curve and the year of overall maximum catch. In 2005, about 22% of the Mediterranean fisheries are characterised as crashed, 39% as overfished, 23% as fully exploited, whereas developing fisheries were confined to less than 16%. These results, although encouraging compared to available global estimates, sound the alarm of fisheries sustainability, and ask immediate conservation and management measures.
Keywords: Fisheries, Conservation

Introduction
Despite the long history of fisheries exploitation of the Mediterranean Sea, data concerning stock assessment are lacking or sporadic, thus inducing a strong impediment for the management of this large marine ecosystem as a whole. Existing stock assessment attempts concern a low number of species, when compared to the multispecies assemblages exploited (i.e. more than 150 commercial species). In contrast, the long time-series of landings available, offer a useful and cheap, yet in some cases unreliable, background information for evaluating the status of fisheries, as well as their ecological footprint [1]. The aim of the present work was to assess the exploitation status of the Mediterranean fisheries stocks for the period 1970-2005 using the methodology of [2], and compare them with the corresponding global trends and/or similar work performed elsewhere.

Materials and methods
The annual landings, expressed as live weight equivalent of catches, have been recorded since 1970 for the Mediterranean and the Black Sea (FAO area 37) by the General Fisheries Commission for the Mediterranean (GFCM) [3]. The GFCM catch data refer to the legal and reported large- and small-scale fisheries, excluding discarded catch, illegal, unreported, recreational and sport fishing. Catch statistics were extracted from the GFCM dataset for all available records or stocks (=species-area combinations). The annual status of fisheries (1970-2005) was classified into one of the following four categories: developing, fully exploited, overexploited, and crashed [2]. The classification is based on the relationship between the catches of a given year compared to the year of overallmaximum catch. Thus, in a developing fishery, the year of catch is before year of maximum catch, and catch is less than 50% of the overall maximum catch; in a fully exploited fishery the catch is greater than 50% of maximum catch; in an overexploited fishery, the year of catch is after year of maximum catch, and catch is between 10% and 50% of the overall maximum catch; and in a crashed fishery, the year of catch is after the year of maximum catch, and catch is below 10% of the overall maximum catch.

Results and Discussion
Based on the overallmaximum landings, which varied among stocks, in 2005 (the most recent year available), 336 out of the 1480 stocks analysed can be classified as crashed (22.7%), 583 as overfished (39.4%), 335 as fully exploited (22.6%) and 226 as developing (15.3%). In the 1970s, the majority of the stocks were largely underexploited and most fisheries (around 80%) were developing (Fig. 1). Only a few stocks were overexploited and even fewer can be characterised as crashed. Over the last 20 years, however, an increasing percentage (averaging 19.6% for 1996-2005) of stocks suffers from overexploitation. The cumulative percentage of overfished and crashed stocks increased dramatically from 10% in 1977, to 20% in 1987, 30% in 1990, 40% in 1995, 50% in 2000 and 60% in 2005. Interestingly enough, the percentage of fully exploited stocks has remained rather unchanged since 1970 (averaging 23.6±2.52% for 1970-2005). The degree of exploitation of the Mediterranean fisheries is disappointing compared to previous estimates for the area (74% of the Mediterranean stocks are either fully exploited or overexploited: [4]) but encouraging compared to the current global pattern (the developing fisheries are less and the overexploited/crashed ones are more: [5]), the NE Atlantic and the North Sea (in 1999, 50% of fisheries were overfished or collapsed: [2]).

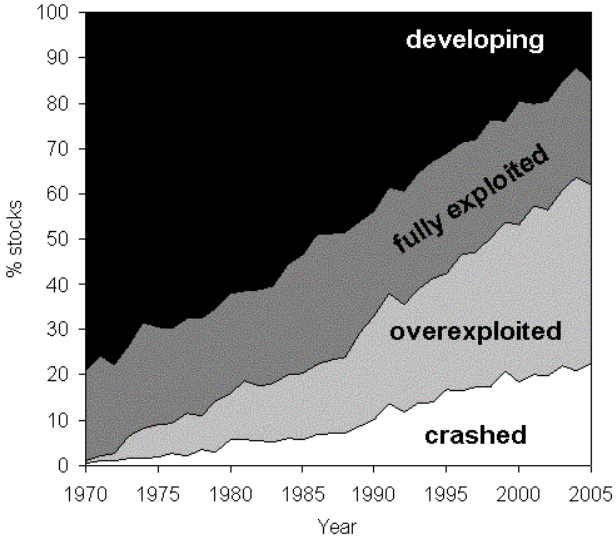


Fig. 1. Trend in the status of Mediterranean marine fisheries resources (1970-2005) based on FAO statistics (status definitions adopted by [2])

Since traditional management schemes seem to have failed to prevent exhaustion of the marine resources, future management should be directed towards reducing fishing effort and excluding large areas from fisheries exploitation.

References
1 - Cury P.M., Shannon L.J., Roux J-P., Daskalov G.M., Jarre A., Moloney D.L. and Pauly D., 2005. Trophodynamic indicators for an ecosystem approach to fisheries. *ICES J. Mar. Sci.*, 62: 430-442.
2 - Froese R. and Pauly D., 2003. Dynamik der Uberfischung. *In*: Lozan J., Rachor E., Reise K., Sundermann J., von Westernhagen H.S. (Eds.), Warnsignaleaus Nordsee und Wattenmeer-eine aktuelle Umweltbilanz. GEO, Hamburg, pp 288–295.
3 - FAO., 2006. Fishery Information, Data and Statistics Unit GFCM capture production 1970-2005. FISHSTAT Plus - Universal software for fishery statistical time series.
4 - Bertrand J.A., 2003. Fisheries and related indicators of fisheries resources and ecosystems: towards an application in the Mediterranean. *Proc. 7th Hellenic Symp. Oceanogr. Fisher.*: 5-10. Crete, 6-9 May 2003.
5 - Sumaila U.R., Khan A., Watson R., Munro G., Zeller D., Baron N., Pauly D., 2007. The World Trade Organization and global fisheries sustainability. *Fish. Res.*,88: 1–4.

TRENDS IN TROPHIC LEVEL OF FARMED FISH IN MEDITERRANEAN COUNTRIES

Athanassios Tsikliras [1]*, Eleni Tsalkou [1], Daniel Pauly [2] and Konstantinos I. Stergiou [3]
[1] Department of Ichthyology and Aquatic Environment, University of Thessaly - tsikliras@uth.gr
[2] Sea Around Us project, Fisheries Centre, University of British Columbia, Vancouver, B.C., Canada, V67 1Z4
[3] Laboratory of Ichthyology, Department of Zoology, School of Biology, Aristotle University of Thessaloniki, UP Box 134, Thessaloniki, Greece

Abstract
The mean trophic level (τ) of the Mediterranean farmed fishes (i.e. excluding crustaceans, cephalopods and bivalves) was estimated on a country basis for the period 1950-2004. Overall, τ increased from a mean value (±SD) of 2.68 (±0.044) for 1950-1959 to 3.21 (±0.031) for 2000-2004, thus confirming that the Mediterranean food webs, overall, are being farmed up. However, the pattern was not uniform across countries; France, Italy Turkey and Israel are farming progressively higher trophic level fishes, while the mean trophic level of farmed fish is declining in Greece, Egypt and Croatia. The overall trend toward farming farming up should be reversed, because it implies non-sustainable pressures on Mediterranean ecosystems.
Keywords: Aquaculture, Fisheries, Fishes, Food Webs

Introduction The trophic level (τ) of fisheries landings and mariculture production has been used to evaluate both their status and that of their supporting ecosystems, notably by testing whether marine food webs are fished down [1] or farmed up [2]. The selective removal of large, high trophic level organisms by fishing lowers their relative contribution to the landings, which are progressively dominated by small fishes, while their mean trophic level declines. The opposite occurs when the contribution of large, high-trophic level organisms produced by mariculture operations increases, and hence the mean trophic level of their aggregate output increases. Both processes are indicators of absent sustainability and ecosystem health; the latter poses additional economic and ethical concerns [2]. The aim of the present work was to assess the extent of farming high-trophic level fishes across the Mediterranean and identify which countries and species contribute to the overall farming up trend of the Mediterranean aquaculture, recently demonstrated to occur based on aggregated data [2].

Materials and methods The marine and brackish water aquaculture production of fishes (i.e., excluding crustaceans, cephalopods and bivalves) of the Mediterranean and the Black Seas was extracted from the GFCM (General Fisheries Commission for the Mediterranean) dataset for the period 1950-2004 [3]. The mean weighted τ [4] for each year was calculated for the Mediterranean part of each of the countries with such production, based on specific estimates of τ taken from the literature, or from FishBase (www.fishbase.org).

Results and Discussion Overall, τ increased from an average value (±SD) of 2.68 (±0.044) for 1950-1959 to 3.21 (±0.031) for 2000-2004, thus confirming that the Mediterranean food webs are being farmed up and that farming up is the result of culturing high trophic level fishes. This confirms the trend established by an earlier analysis of the farming-up effect in the Mediterranean [2]. However, the absolute values of τ are not straightforwardly compared, as their pertained to a shorter time period (1970-2004), and were based on more aggregated data. The main fish culturing Mediterranean countries for 2004 were Greece (65000 t), Turkey (47000 t), Egypt (43000 t), Italy (14000 t), France (5000 t), Croatia (4000 t) and Israel (3000 t). From these countries, Turkey (mean τ±SD=3.46±0.001), France (mean τ±SD=3.50±0.015), Italy (mean τ±SD=3.36±0.116) and Israel (mean τ±SD=3.45±0.005) are progressively culturing higher trophic level fishes, whereas Greece (mean τ±SD=3.44±0.001), Egypt (mean τ±SD=2.40±0.204) and Croatia (mean τ±SD=3.48±0.007) are not (Figure 1, mean τ refers to 2000-2004). The rate of τ increase is higher in Italy (0.15 per decade) and Turkey (0.05 per decade) compared to France (0.015 per decade) and Israel (0.02 per decade) and is mainly attributed to the increasing percentage of cultured seabass (*Dicentrarchus labrax*) and seabream (*Sparus aurata*). The declining percentage of low trophic fishes in the Mediterranean aquaculture may enhance this trend in the future. It should be noted that the effect of bluefin tuna (*Thunnus thynnus*) fattening [5] was not yet identifiable in the 2004 dataset. As noted earlier [2], the farming of seabass and seabream, and the fattening of bluefin consume far more fish (sardine, anchovies, etc.) for feed than these operations produce, which thus contribute to reducing the net supply of fish available for human consumption. Along with the many environmental problem caused by the farming of carnivorous fish, this argues for a need to return to more sustainable forms of mariculture, notably bivalve aquaculture, which has a long tradition in the Mediterranean.

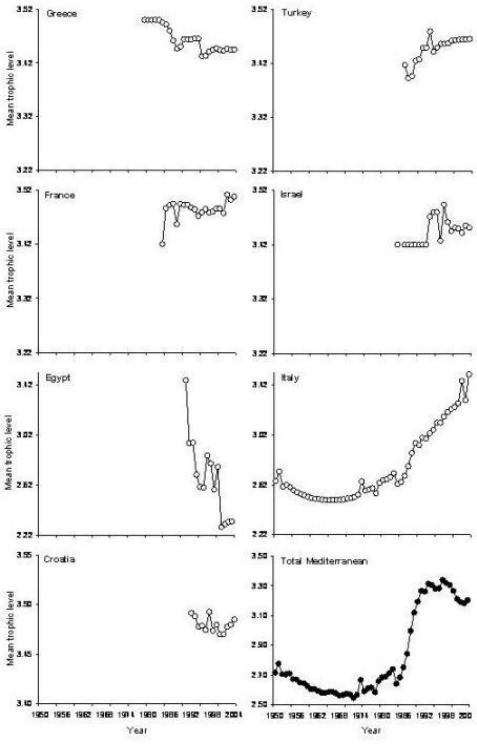


Fig. 1. Mean weighted trophic level variability of the Mediterranean cultured fishes for the main producing countries (1950-2004). The four bottom panels (Egypt, Italy, Croatia and Total Mediterranean) are not in the same scale.

References
1 - Pauly D., Christensen V., Dalsgaard J., Froese R. and Torres F. Jr, 1998. Fishing down marine food webs. *Science*, 279: 860–863

2 - Stergiou K.I., Tsikliras A.C. and Pauly D., 2009. Farming up the Mediterranean food webs. *Conserv. Biol.*, 23: 230-232

3 - FAO Fishery Information, Data and Statistics Unit. 2006. Aquaculture production 1950-2004. FISHSTAT Plus - Universal software for fishery statistical time series. Food and Agriculture Organization of the United Nations

4 - Gascuel D. and Pauly D., 2009. EcoTroph: Modelling marine ecosystem functioning and impact of fishing. *Ecol. Model.* 220: 2885–2898

5 - Ottolenghi, F., 2008. Capture-based aquaculture of bluefin tuna. In: Lovatelli, A., Holthus, P. F., (Eds.), Capture-based aquaculture. Global overview. *FAO Fisheries Technical Paper*. No. 508. FAO, Rome. pp. 169–182

FEEDING GUILD COMPOSITION OF A GASTROPOD MACROBENTHIC COMMUNITY IN THE NORTH AEGEAN SEA

Irini Tsikopoulou [1]*, Chryssanthi Antoniadou [1], Eleni Voultsiadou [1] and Chariton Chintiroglou [1]
[1] Department of Zoology, School of Biology, Aristotle University of Thessaloniki - etsikopo@bio.auth.gr

Abstract
The aim of this study was to examine temporal changes in feeding type composition of a macrobenthic gastropod community in Thermaikos Gulf, north Aegean Sea. Throughout the sampling period a gradual increase in the abundance of carnivores was observed, which implied a natural or anthropogenic disturbance in the area during the study period.
Keywords: Aegean Sea, Gastropods, Mollusca

Introduction
Hydrodynamics and other environmental parameters may induce temporal and spatial changes in feeding guilds composition in marine sediments, eventually modifying the structure of macrobenthic communities [1]. Moreover, trophic type composition of benthic mollusc communities has been used as indicator of environmental stress induced by organic enrichment [2]. This study investigates temporal modifications of macrobenthic mollusc communities in the north Aegean Sea on the basis of feeding guild composition.

Materials and Methods
Three annual samplings were carried out from summer 2001 to winter 2004. Three vertical transects along the NE coasts of Thermaikos Gulf were set up and six stations were selected for benthic macrofauna sampling using corers, at depths between 3 and 10 m. Gastropods were classified into five feeding guilds: carnivores, detritus feeders, herbivores, suspension feeders and parasitic species ([1], [2], [3], [4]). The non-parametric Kruskal–Wallis test was used to confirm or reject the null hypothesis that the distribution of each feeding type was the same during the sampling period [5].

Results and Discussion
In total, 6931 gastropods were collected and identified in 62 species. Of these, 33 were assigned to carnivores, 14 herbivores, 7 detritus feeders, 2 suspension feeders and 6 parasites. The different feeding guilds were unevenly distributed in the three sampling periods in terms of numbers of individuals and species richness (Figure 1). The abundance of carnivores increased though time ($H_{kruskal\text{-}Wallis}$= 45.02; $p<0.01$), whereas species richness did not follow a specific pattern ($H_{kruskal\text{-}Wallis}$= 65.07; $p<0.01$). Adversely, detritus feeders showed a decreasing trend in their abundance ($H_{kruskal\text{-}Wallis}$= 59.15; $p<0.01$) but there was no specific pattern in species richness ($H_{kruskal\text{-}Wallis}$= 32.94; $p<0.01$) (Figure 1). The increasing dominance of carnivores against detritus feeders might be a result of natural or anthropogenic disturbances in the sampling area [1], thus confirming the observations of Antoniadou et al. [6] who attributed such changes to the increase of organic pollution in the northern transect of the study area. In conclusion, the feeding guild composition of a macrobenthic gastropod community can be a useful tool for biodiversity studies and monitoring surveys in marine coastal ecosystems.

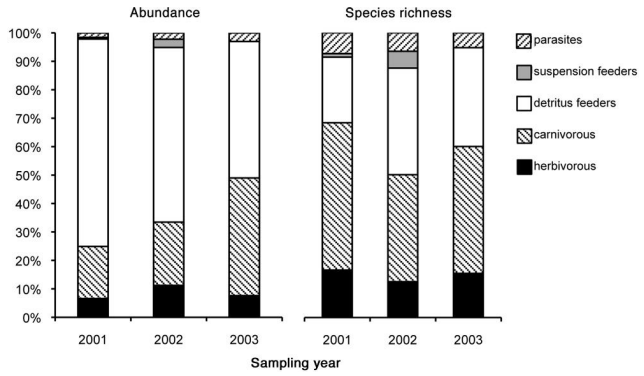


Fig. 1. Temporal variation in feeding guild composition of a gastropod macrobenthic community

References
1 - Dolbeth M., Teixeira H., Marques J.C. and Pardal M.A., 2009. Feeding guild composition of macrobenthic subtidal community along a depth gradient. *Sci. Mar.*, 73: 225-237.
2 - Dimitriadis C. and Koutsoubas D., 2008. Community properties of benthic molluscs as indicators of environmental stress induced by organic enrichment. *J. Nat. Hist.*, 42: 559-574.
3 - Bloom S. A., 1983. Seasonality and structure of a macrobenthic seagrass community on the Florida gulf coast. *Int. Revue ges. Hydrobiol.*, 68: 539-564.
4 - Russo G. F., 1985. Il popolamento a molluschi dei fondi mobile del Golfo di Salerno: analisi strutturale in rapporto al trofismo [Mollusc population in the soft bottoms of the Gulf of Salerno: structural analysis in relation to trophism]. *Oebalia*, 11: 339-348.
5 - Siegel S., 1956. Nonparametric statistics for the behavioral sciences (2nd ed.), McGraw-Hill Book Company, New York, pp 312.
6 - Antoniadou C., Krestenitis Y. and Chintiroglou C., 2004. Structure of the "amphioxus sand" community in Thermaikos bay (Eastern Mediterranean). *Fresen. Environ. Bull.*, 13: 1122-1128.

EUSEAMAP PROJECT: MODELLING EUROPEAN SEABED HABITATS - A FOCUS ON THE WESTERN MEDITERRANEAN

L. Tunesi [1]*, S. Agnesi [1], A. Cameron [2], N. Coltman [2], A. Hamdi [3], V. Lopez [4], G. Mo [1], J. Populus [3], J. Sanz Alonso [4], S. Sartoretto [3] and D. Connor [2]

[1] ISPRA - leonardo.tunesi@isprambiente.it

[2] JNCC

[3] IFREMER

[4] IEO

Abstract

This document gives an overview of the EUSeaMap project and its part in the implementation of the EC policies involving marine habitat mapping. The EUSeaMap project will produce broad-scale predictive habitat maps for over 2 million square kilometres of European seabed covering four geographic areas of the European seas: Celtic, North, Baltic and western Mediterranean seas. Some preliminary results for the western Mediterranean are given.

Keywords: Mapping, Models, Western Mediterranean

Marine habitat mapping is required for the implementation of various EC Directives and Regulations in that it is the baseline for environmental assessment and monitoring requirements as well as for the enactment of protection measures for marine habitats and species. In its Blue Book on an integrated maritime policy for the European Union, the EC proposed to take steps towards building a network that "*assembles fragmented and inaccessible marine data into interoperable, contiguous and publicly available data streams for complete maritime basins*". EUSeaMap is a preparatory action, funded by the DG MARE, that is functional to the setting up of this European network through the creation of models capable of predicting seabed habitat maps. The project aims to provide a tool for marine spatial planning by Member States and at the same type supports the implementation requirements of the Marine Strategy Framework Directive. The EUSeaMap is run by a consortium of partners (BLST, Denmark; DHI, Denmark; IFREMER, France; IEO, Spain; ISPRA, Italy; SEPA, Sweden) led by the Joint Nature Conservation Committee (UK). The project is based on the habitat modelling approach developed within the framework of the previous INTERREG IIIB-funded MESH [1] and BALANCE [2] projects, and will develop a common methodology for broad-scale seabed habitat mapping across Europe, using the EUNIS classification (http://eunis.eea.europa.eu/) across four marine study-areas covering over 2 million square kilometres of Europe's seabed: the Celtic, North, Baltic, and western Mediterranean Seas. The EUNIS habitat classification scheme, originally developed in 1996 by the EEA, has recently incorporated several marine habitat lists developed at biogeographic levels. Such is the case for the North Atlantic habitats, identified by Connor *et al*. [3], which have been incorporated into EUNIS. Similarly, a list of benthic Mediterranean habitats adopted under the framework of the Barcelona Convention [4], has also been incorporated into EUNIS [5]. To this effect, EUNIS represents a univocal comprehensive system for the identification and classification of marine habitats across European seas, a long needed measure as pointed out by several authors [6].

The project will introduce better quality habitat maps through the use of best-available data and refined modelling processes. It will make the digital map layers available to stakeholders and develop an on-line mapping tool to display the layers. Attention will be focussed on assessing the benefits and constraints of a broad-scale habitat map with respect to higher resolution maps produced from detailed survey data, and demonstrate how the Marine Strategy Framework Directive Annex III requirements can be used in characterising the marine environment. This exercise will allow estimation of the effort required to develop complete broad-scale coverage of waters surrounding the European continent as well as higher resolution ones. The EUSeaMap will utilise GIS software to model seabed habitats through the assembling and integration of several layers representing abiotic parameters (sediment, bathymetry, light, wave and tidal energy at seabed, salinity at seabed, temperature at seabed, dissolved oxygen, ice cover, stratification). Careful selection and analysis of ecologically relevant thresholds will be performed for each abiotic parameter in every region. Through the expert application of the EUNIS classification scheme, combinations of these parameters will be used to predict habitats at the high level habitats of EUNIS (levels 3 and 4).The approach will also quantify the degree of confidence of the generated maps. This will be done both on the basis of the source of each data layer used, and through the use of fuzzy boundaries for habitats, according to our knowledge of the required conditions for a given habitat to occur. The array of abiotic parameters used to model habitats will vary according to each study area.

In the western Mediterranean sea the following parameters will be used: sediment, bathymetry, light, energy at seabed, temperature at seabed. Since the nature of the broad scale map determines a pixel size of analysis of 250 m, it is expected that at least 15 habitat types, according to the EUNIS classification, will be modelled in this basin. The habitats expected to be modelled for the Mediterranean (see Table 1.) are distributed as follows: 3 in the infralittoral zone, 7 in the circalittoral, 4 in the bathyal and 1 in the abyssal zone.

Tab. 1. List of the Mediterranean habitats to be modelled.

EUNIS Habitat code	Eunis name (in parenthesis eventual notes)	RAC/SPA Code [4]
A3	Infralittoral rock and other hard substrata	III.6.
A5.23	Infralittoral fine sands	III.2.
A5.28	Infralittoral Mediterranean biocenosis of superficial muddy sands in sheltered waters	III.2.3.
A4.26	Mediterranean coralligenous communities moderately exposed to hydrodynamic action (we intend Coralligenous beds)	IV.3.1
A5.51	Maerl beds (we intend Rhodoliths beds in general)	VI.2.2.1; VI.2.2.2
A5.46	Mediterranean biocoenosis of coastal detritic bottoms	IV.2.2.
A5.38	Mediterranean biocoenosis of muddy detritic bottoms	IV.2.1.
A5.39	Mediterranean biocoenosis of coastal terrigenous muds	IV.1.1.
A4.27	Faunal communities on deep moderate energy circalittoral rock	IV.3.3.
A5.47	Mediterranean communities of shelf-edge detritic bottoms	IV.2.3.
A6.1	Deep-sea rock and artificial hard substrata	V.3.
A6.51	Mediterranean communities of bathyal muds	V.1.1.
A6.511	Facies of sandy muds with *Thenea muricata*	V.1.1.1.
A6.3	Deep-sea sand	V.2.
A6.52	Communities of abyssal muds	VI.1.1.

EUSeaMap will produce a modelled EUNIS habitat map, harmonised across the four regions, as well as associated confidence layers available through a purpose built webGIS. The webGIS will comply with INSPIRE standards and the layers will be available for viewing through WISE-Marine on its inception. The project will assess the feasibility and work resources required to extending the modelling process to other regions of Europe to produce broad-scale EUNIS habitat maps. Furthermore, it is proposed to provide generic resource requirements for new remote and ground-truth survey, probably per unit area, adjusted to suit the different major zones for survey.

References

1 - Coltman N., Golding N. and Verling E., 2006. Developing a broadscale predictive EUNIS habitat map for the MESH study area. *In:* MESH Guide to Marine Habitat Mapping, www.searchmesh.net

2 - Al-Hamdani Z. and Reker J., (eds) 2007. *Towards marine landscapes in the Baltic Sea*. BALANCE Interim Report No. 10. Publication of the Geological Survey of Denmark and Greenland www.balance-eu.org

3 - Connor D.W., Allen J.H., Golding N., Howell K.L., Lieberknecht L.M., Northen K.O. and Reker J.B., 2004. The marine habitat classification for Britain and Ireland, version 04.05. Joint Nature Conservation Committee (JNCC), UK.

4 - RAC/SPA, 2006. Classification of benthic marine habitat types for the Mediterranean region. Available online http://www.rac-spa.org/dl/telechargement/SDF/LCHM ENG.pdf.

5 - Tunesi L., Moss D., Evans D., Mo G. and Di Martino V., 2006. The Mediterranean Marine Habitats in the "EU.N.I.S." European System. *Biol. Mar. Mediterr*., 13 (2): 224-225.

6 - Fraschetti S., Terlizzi A. and Boero F., 2008. How many habitats are there in the sea (and where)?. *J. Exp. Mar. Biol. Ecol.*, 366: 109-115.

PHYLOGENETIC RELATIONSHIP AMONG THE BLACK SEA *ALOSA* SPECIES FROM MTDNA ND5/6 SEQUENCES

Cemal Turan [1]*, Deniz Erguden [1] and Funda Turan [1]
[1] Fisheries Genetic Laboratory, Faculty of Fisheries, Mustafa Kemal University - cturan@ymail.com

Abstract
Phylogenetic relationships among five species of *Alosa* (*Alosa maeotica, A. tanaica, A. caspia, A. immaculata* and *A. fallax nilotica*) was examined with sequence analyses of mtDNA ND5/6 region. In pairwise comparision, the highest genetic differences were observed between *A. caspia* and *A. tanaica* (0.691), and lowest between *A. maeotica* and *A. tanaica* (0.491). In minimum evolution tree, two phylogenetic nodes were detected; in the first node, *A. maeotica* and *A. tanaica* grouped together which were sister group to *A. f. nilotica*. In the second node, *A. caspia* and *A. immaculata* grouped together.
Keywords: Genetics, Teleostei, Black Sea

Introduction
Shad (*Alosa spp.*) is one of the most important fish resources and have high economic value in the world [1]. Shad species are commonly found in the Black Sea and represented with four species and one subspecies [1,2]. *Alosa maeotica, Alosa tanaica, Alosa immaculata, Alosa caspia* are distributed in the Black Sea. *Alosa fallax nilotica* is distribution in the Black, Marmara, Aegean and Mediterranean Seas. Knowledge on phylogenetic relationship among these species is important to elucidate evolutionary history and genetic relationships among these species. In the present study it is aimed to elucidate phylogenetic relationships among *Alosa* species with sequence analyses of mtDNA ND5/6 region.

Material and Methods
Speciments of *A. maeotica, A. tanaica, A. caspia, A. immaculata* and *A. f. nilotica* were collected from the Black Sea. The samples were placed individually in plastic bags, and kept frozen at -40°C until the molecular analyses. Total genomic DNA was extracted from a peace of fin tissue (approximately 2 mm^2) using Midi DNA isolation Kits. The amplification of the mitochondrial ND5/6 gene was performed using PCR with a profile of 94°C for 4 min, followed by 35 cycles of 94°C/30s strand denaturation, 52° C/20s annealing and 72 °C/1 min 30 sec primer extension, and a final 7 min elongation at 72°C. Purified DNA (3-5 µl) was sent to IONTEK for sequencing, using primers (F: 5'-AAC AGT TCA TCC GTT GGT CTT AGG-3' and R: 5'-TAA CAA CGG TGG TTC TTC AAG TCA-3'). Sequences were aligned and ambiguous bases resolved by eye using Sequencer v.4.5 (Gene Codes Corp.). The initial alignments of partial 16S rDNA sequences were performed with Clustal W program [3] and final alignment was completed manually with BioEdit [4]. MtDNA sequence data were analyzed to assess levels of pairwise nucleotide variation and to determine nucleotide composition for each taxon using Mega 4 [5]. The molecular phylogenetic tree was constructed using the three distinct phylogenetic approaches: a distance-based method using neighbor joining (NJ), [6] a cladistic approach using the maximum parsimony (MP) criterion, and minimum evolution (ME). The reliability of the inferred phylogenies was evaluated using the bootstrap method [7] with 1000 replicates. One species, *Engraulis encrosicolusrom*, were included as an out group taken from GenBank (NC003097).

Results and Discussion
There were 888 variable and 16 conservative nucleotides of which 857 were parsimony informative over 904 bp. Examination of the gene fragment reveals a lack of guanin (T; 18.1%) and abundance of adenine (A; 30.3%). The mean nucleotide diversity (*Pi*) was found to be 0.516. For congeneric comparisons of genetic distance (Kimura two parameter), the highest genetic differences were observed between *A. caspia* and *A. tanaica*, and lowest between *A. maeotica* and *A. tanaica* (Table 1). The three different phylogenetic approaches (NJ, MP, ME) resulted in similar tree topologies and the clades are well supported (Fig. 1). In minimum evolution tree, two phylogenetic nodes were detected; in the first node, *A. maeotica* and *A. tanaica* grouped together which were sister group to *A. f. nilotica.* In the second node, *A. caspia* and *A. immaculata* grouped together. Similarly Faria et al [8] also clustered *A. caspia* and *A. immaculata* together and found close relationship for these two *Alosa* species in the Black Sea using ND1 and Cytochrome b genes.
Acknowledgements: Thanks to the Scientific & Technological Research of Turkey (TUBITAK-106T149) for financial support.

Tab. 1. Pairwise genetic distance between the species

Species	*A.maeotica*	*A.caspia*	*A.immaculata*	*A.f.nilotica*	*A.tanaica*
A.maeotica	-				
A. caspia	0.690	-			
A.immaculata	0.655	0.519	-		
A.f.nilotica	0.610	0.690	0.668	-	
A. tanaica	0.491	0.691	0.689	0.650	-

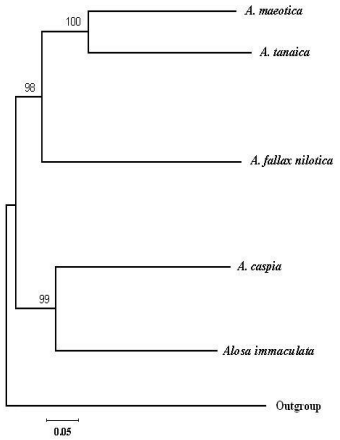


Fig. 1. Minimum evolution phylogenetic tree for ND5/6. Bootstrap values are shown on the tree. *E. encrosicolus*, seq. (NC003097) was used as outgroup species

References
1 - Whitehead P.J.P.Bauchot M.L., Hureau J.C., Nielsen J. and Tortonese E., 1984. Clupeidae. Fishes of the North-Eastearn Atlantic and the Mediterranean.(eds.), UNESCO, Paris, Vol. 1, p 510.
2 - Turan C., Özturk B., Erguden D**.,** Gurlek M. and Yaglioglu D., 2007. Atlas of Marine Bony Fishes of Turkey. *In*: Turan C. (ed.), Atlas and Systematic of Marine Bony Fishes of Turkey. Nobel Publishing House, Adana, pp 83-485.
3 - Thompson J.D., Higgins D.G. and Gibson T.J., 1994. Clustal W: Improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position specific gap penalties and weight matrix choice. *Nuc. Acid Res.*, 22: 4673-4680.
4 - Hall T.A., 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucl. Acids Symp. Ser.*, 41: 95-98.
5 - Tamura K., Dudley J., Nei M. and Kumar S., 2007. MEGA 4: Molecular evolutionary genetics analysis (MEGA) software version 4.0. *Mol. Biol. Evol.*, 24: 1596-1599.
6 - Saitou N. and Nei M., 1987. The neighbour-joining method: a new method for reconstructing phylogenetic trees. *Mol. Biol. Evol.*, 4: 406-425.
7 - Felsenstein J., 1985. Confidence limits on phylogenies: an approach using the bootstrap. *Evolution*, 39: 783-791.
8 - Faria R., Weiss S. and Alexandrino P., 2006. A molecular phylogenetic perspective on the evolutionary history of *Alosa spp*. (Clupeidae). *Mol. Phyl. Evol.*, 40: 298-304.

DIEL FLUCTUATIONS IN JUVENILE DOMINATED FISH ASSEMBLAGES ASSOCIATED WITH SHALLOW SEAGRASS AND BARE SAND IN SOUTHERN ADRIATIC SEA, CROATIA

P. Tutman [1]*, N. Glavic [2], V. Kožul [2], N. Antolovic [2] and B. Skaramuca [3]

[1] Institute of Oceanography and Fisheries, POB 500, 21000 Split, CROATIA - tutman@izor.hr

[2] Institute for Marine and Coastal Research, University of Dubrovnik, POB 83, 20000 Dubrovnik, CROATIA

[3] University of Dubrovnik, Department for Aquaculture, Cira Carica 4, 20000 Dubrovnik, CROATIA

Abstract

Diel changes were investigated in fish assemblages associated with shallow seagras (*Posidonia oceanica*) and bare sand in two southern Adriatic Sea coves. Habitat related differences in assemblages were strong day and night, and were greater than diel changes. The seagrass associated assemblages remained similar day and night and consistently differed from sand associated. In contrast, the assemblages over sand varied on a diel basis as larger individuals of several species (e.g. *Atherina boyeri, Sarpa salpa, Conger conger*) that resided over other habitats during the day, were caught at night. Both habitats were utilized by newly recruited juveniles of economically important species and their habitat associations generally did not differ on a diel basis. Hence, both habitats are considered important to the fisheries of southern Adriatic.

Keywords: Fishes, Biodiversity, Adriatic Sea

Introduction

The shallow-water vegetated inshore areas generally support different and more diverse and abundant fish assemblages than non-vegetated habitats, as well as being considered more important as nursery areas for juveniles of many economically important species [1]. This phenomenon is classically explained by considering the high structural complexity of such vegetated (mainly seagrasses) systems, which are able to fulfill the role of nursery areas in providing shelter and food to a great number of littoral fish species [2]. These conclusions have primarly been based on daytime sampling programmes, even though many littoral species of fish display strong diel rhythms of activity and diel changes in habitat-usage by fishes have been documented [3]. Thus, decision about the relative importance of different habitats to fishes based solely on daytime sampling are often equivocal. The objective of this study was to examine diel changes in the fish assemblages associated with the shallow seagrass (*Posidonia oceanica*) and unvegetated (bare sand) habitats.

Material and methods

Monthly samples of the shallow-water fish assemblage were collected with a small beach seine (mesh size 8 mm at outer wings and 4 mm at the bag end, knot to knot) between May 2007 and April 2008, every 4-h over 24-h period (daily samples were taken at 08.00, 12.00, 16.00h; while night samples at 20.00, 24.00, and 04.00h) in the two different areas; Donji Molunat (N 42° 27'27,5"; E 18°25'34,5") and Prapratna (N 42°48'58.1"; E 17°40'50.6") coves, southern Adriatic Sea. The substratum in Donji Molunat is shallow seagrass (*Posidonia oceanica*) while in Prapratna cove is clean sand. Sampling depth ranged from 4.0 to 0 m. The fish data were analysed using the PRIMER software package. Data were transformed for presence/absence and the Bray-Curtis similarity matrix was used to generate 2-dimensional ordination plots with the non-metric multidimensional scaling (nMDS) technique [4].

Results

A total of 64231 fishes comprising 83 species was caught; 12429 fishes (67 species), occurred over seagrass, whereas 51802 fishes (58 species), occurred over sand. Most fish were juveniles, mainly young-of-the-year, amounting a total of 89%. The dominant species of Donji Molunat, *Boops boops* (48,85%), *Coris julis* (7,65%), *Pagellus bogaraveo* (6,64%), *Sardina pilchardus* (5,72%) and Prapratna cove, *Boops boops* (57,21%), *Atherina boyeri* (19,70%), *Sardina pilchardus* (19,70%) and *Sarpa salpa* (6,60%) were caught in consistently higher numbers and biomass in different time of diel period. A greater number of species was caught over seagrass than over sand, day (52 *vs*. 48) and night (55 *vs*. 50). However, more individuals tended to occur over seagrass (9467) than sand (4627) during the day. At the assemblage level, slightly more individuals over seagrass were caught during daytime, whereas in Prapratna Bay dominated nighttime assemblage in both terms. Non-parametric Spearman's correlation test showed no signifficant correlation on composition and abuundance between these coves (r_S=0,210, p=0,187). The nMDS plot shows clear separation of the investigated areas (Fig. 1).

Discussion

The ichthyofauna was generally more diverse over seagrass than over sand both day and night, and more fish generally occurred over seagrass than over sand during the day, as reported elsewere [5]. The habitat-related differences in the fish assemblages were because many species consistently occurred in only one habitat, or were predominantly caught in one habitat, both day and night. Different types of fishes were generally associated with the two habitats, as discussed by [5,6]. The structure of the seagrass-associated assemblages did not differ substantially between day and night, as observed in other parts of the world [7]. However, significant diel change in the structure of the sand-associated assemblages was evident, which was primarly due to the influx of several species over sand at night. Changes in assemblage structure observed were caused by shifts in abundance of a particular species rather than by their presence and/or absence. In spite of diel changes in some species occurrence in both coves, no strong evidence for the existence of distinct day and/or night communities was detected. The predominance of juveniles in the catches indicate that these coves serve as nursery and feeding grounds.

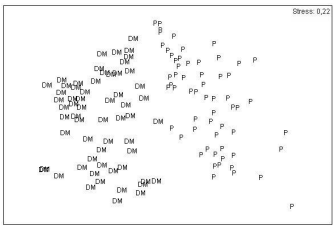


Fig. 1. Non-Metric Multidimensional Scaling (nMDS) ordination plot for fish assemblages in Donji Molunat (DM) and Prapratna (P) cove among day and night sampling

References

1 - Bell J.D. and Pollard D.A., 1989. Ecology of fish assemblages and fisheries associated with seagrass. *In:* Larkum A.W.D., McComb A.J. and Shepherd S.A. (eds.), Biology of Seagrasses. Elsevier, Amsterdam, pp 565-609.

2 - Guidetti P., 2000. Differences among fish assemblages associated with nearshore *Posidonia oceanica* seagrass beds, rocky-algal reefs and unvegetated sand habitats in the Adriatic sea. *Estuar. Coast. Shelf S.*, 50: 515-529.

3 - Rountree R.A. and Able K.W., 1997. Nocturnal fish use of New Jersey marsh creek and adjacent bay shoal habitats. *Estuar. Coast. Shelf S.*, 44: 703-711.

4 - Clarke K.R. and Warwick R.M., 2001. Change in marine communities: an approach to statistical analysis and interpretation. 2nd edit Plymouth: PRIMER-E Ltd.

5 - Gray C.A., Chick R.C. and McElligott D.J., 1998. Diel changes in assemblages of fishes associated with shallow seagrass and bare sand. *Estuar. Coast. Shelf S.*, 46: 849-859.

6 - Jenkins G.P., May H.M.A., Wheatley M.J. and Holloway M.G., 1997. Comparison of fish assemblages associated with seagrass and adjacent unvegetated habitats of Port Phillip Bay and Corner Inlet, Victoria, Australia, with emphasis on commercial species. *Estuar. Coast. Shelf S.*, 44: 569-588.

7 - Bell J.D. and Harmelin-Vivien M.L., 1982. Fish fauna of French Mediterranean *Posidonia oceanica* seagrass meadows. 1. Community structure. *Tethys* 10: 337-347.

AN ASSESSMENT OF THE STATE OF MARINE ECOSYSTEMS AROUND TURKEY DURING SESAME (BLACK SEA, TURKISH STRAITS SYSTEM AND THE LEVANTINE BASIN)

Z. Uysal [1], S. Tugrul [1], N. Yücel [1], F. Sert [1], A. Gazihan [1], Y. Ak örek [1], T. Terbiyik [1], H. Örek [1] and E. Özsoy [1]*
[1] Institute of Marine Sciences, METU - ozsoy@ims.metu.edu.tr

Abstract

Deeply contrasting coastal / open ocean ecosystems have been investigated in the April and October 2008 cruises of the R/V BILIM during the SESAME project, covering the Cilician Basin, a north-south transect of the Levantine Basin, the Aegean coast of Turkey, the Turkish Straits System (TSS), and finally a transect arching over the mid-section of the Black Sea starting from the Bosphorus and extending east. Earlier work in April 2007 in the Turkish Straits and a repeated earlier cruises in the Cilician Basin since 2005 have provided additional data. Physical, chemical and biological oceanographic measurements and satellite data provide a basic description of the state of the different ecosystems, ranging from oligotrophic open waters to eutrophicated coastal / shelf areas supplied with water and nutrients from the large rivers.

Keywords: Circulation, Straits And Channels

The Black Sea, a land-locked deep basin occupied with brackish waters, possesses distinctly different biochemical properties due to the presence of oxygenated in the upper layer and sulfide-bearing waters below a depth of 100-150 m and a transition zone in between (1). Comparison of the new and historical data sets indicates long-term changes in Black Sea upper layer chemistry. In this period, the nitrate stock of the upper layer has increased by 2-3 times as silicate stock displayed an opposite trend in the upper layer down to onoxic intreface since the 60's [2-3]. Thus, nitrate/silicate ratio decreased drastically in the upper layer throughout the basin [4]. However, there has been a slow increasing trend in the surface silicate values in the last decade, suggesting progressive changes in the Black Sea ecosystem. The suboxic zone, having distict chemical features, remained enlarged since 80's. Present results demonstrate that regionally variable vertical features of nutrients and dissolved oxygen remained similar in the western cyclonic gyre since 80's. However, lateral intrusion of oxygenated and nutient rich Bosphorus plume into the intermediate depths of SW shelf zone appears to modify basic features that appear in the westen cyclone. Depth integrated primary production rates ranged between 16 and 45 mgC.m-2h-1 in the eastern and western Black Sea stations in April and September 2008. A highly significant correlation exists (P = 0.001 n = 59 r= 0.59) between total chlorophyll and primary production rates. In-situ chlorophyll values were higher in spring than in fall. Concentrations ranged between up to 5 µg/L in spring-08, and 1.6 µg/L in autumn-08.

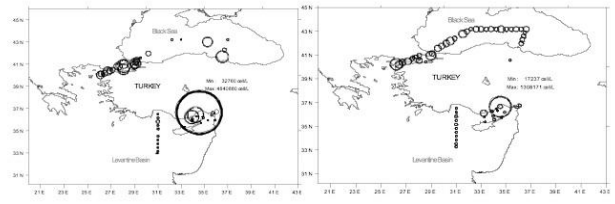


Fig. 1. Surface distribution of phytoplankton abundance (cells/l) in April and September 2008

In the Cilician basin of NE mediterranean, river discharges with large nutrient loads make eutrophic nearshorewaters of Mersin Bay. Upper layer of the Levantine Sea are depleted in nitrate and phosphate during the year, excluding the Rhodes cyclonic gyre in winter months. Nitrate/PO4 molar ratio has remained almost constant at levels of 25-28 during the last two decades, implying P-limited primary productivity in the euphotic zone as experienced in recent studies in the region. However, present POM data show that C/N ratio in the oligotrphic sea is very similar to the classical Redfield ratio, but lower than the those estimated for the more productive Black Sea ecosyetm during SESAME surveys. Primary Production (PP) rates ranged from 3.5 in the offshore to 40 mgC.m-2h-1 in nearshore waters of Mersin Bay enriched by river and domestic discharges. Phytoplankters were found overhelmingly abundant in shallow shelf waters under direct influence of river discharges in the Cilician basin and least in highly oligotrophic offshore waters in the Levantine basin. The mesozooplankton biomass and abundance decreased with inceasing depth (down to 200 m) in the Levantine Basin during study periods.

With the onset of stratification in fall, bacteria dominated the upper layers more efficiently compared to the spring period.

In the two-layer Marmara Sea ecosystem, the productive upper layer water is depleted in nitrate and phosphate; however, an enrichment is recorded in the Marmara-Bosphorus Junction due to intensive mixing of counterflows with different nutrient properties. Therefore, the euphotic zone is more productive and has higher algal biomass and POM than Black Sea open waters. Its lower layer are hypoxic levels of DO (between 30-100 µM), enriched in nutrients but with much lower N/P ratios (8-10) than in the oxygenated NE Mediterranean deep layer, due to denitrification in oxygen-depleted bottom waters of Marmara basin. Peak values of chlorophyll were measured in the Sea of Marmara. Phytoplankton standing stock reflections from the Sea of Marmara and the Black Sea were also significantly high.

Maximum heterotrophic bacterial and cyanobacterial abundance and biomass were observed in the sea of Marmara during fall with values ranging between 2.6x10^6 cells/ml and 14.4 µgC/l for heterotrophic bacteria and 2.1x10^5 cells/ml and 25.3 µgC/l for cyanobacteria. In contrast lowest levels were attained during fall in the Levantine Basin with values ranging between 1.5x10^2 cells/ml and 0.02 µgC/l for heterotrophic bacteria and 1.5x10^2 cells/ml and 0.02 µgC/l for cyanobacteria. Sea of Marmara held the highest bacterial population in both seasons and it was followed by the Black Sea and the Eastern Mediterranean. Both the surface bacterial and cyanobacterial abundance and biomass averages peaked in fall compared to spring at all regions except the apparent decrease in heterotrophic bacterial abundance and biomass in the sea of Marmara.

References

1 - Sorokin Yu. I., 1983. The Black Sea. In: Estuaries and Enclosed Seas. Ecosystem of the World, B. H. Ketchum, editor. Elsevier, Amsterdam, pp. 253-291.

2 - Tugrul, S., Bastürk, Ö., Saydam, C. and Yilmaz, A., 1992. Changes in the hydrochemistry of the Black Sea inferred from water density profiles. *Nature*, 359: 137-139.

3 - Konovalov S. K. and Murray J. W., 2001. Variations in the chemistry of the Black Sea on a time scale of decades (1960-1995). *Journal of Marine Systems*, 31: 217-243.

SOMATIC AND GONADAL MOSAICISM DETECTION IN CULTURED FISH BY RAPD-PCR

Irem Uzonur [1]*, Kubra Sari [1], Tugba Senel [1] and Arzu Erol [1]
[1] Fatih University, Biology Department - iuzonur@fatih.edu.tr

Abstract

DNA samples of organs and tissues from cultured fish: *Oncorhynchus mykiss*, *Sparus auratus* and *Dicentrarchus labrax* have been analyzed by PCR amplification with random primers. Among the 20 random 10-mer nucleotide primers tested, four that yield stable, well reproducible profiles of amplification products were chosen for further genome-wide mosaicism analysis. With these primers, the differences in the RAPD profiles of some tissues were detected in several individuals. These differences were associated with the modification of mobility or with the gain/loss of the fragment in the RAPD profile and could be caused by either genomic rearrangements or mutations involving the regions of DNA-primer pairing. Different epigenetic factors may also contribute to this process.

Keywords: Aquaculture, Fisheries, Fishes, Genetics, Monitoring

Introduction

The random amplified polymorphic DNA (RAPD) method has initially been used to detect polymorphisms in genetic mapping, taxonomy and phylogenetic studies and later genotoxicity and carcinogenesis studies. Despite its extensive use, this technique has also attracted some criticisms, mainly for lack of reproducibility [1]. RAPD assays have a great potential for the detection of DNA effects, alterations and damages including DNA adduct formations, breaks, point mutations, large rearrangements, and other changes, such as structural distortions induced by chemical or physical agents following the direct and/or indirect interactions with the genomic DNA. It has proven to be an efficient molecular tool for the identification of differences among natural populations, when provided with reliable reference samples [2-4]. Molecular evaluation of DNA effects by RAPD profiling can be a method capable of identifying environmental threats earlier than the used standard methods. Traditional approaches to the assessment of the impact of pollution on aquatic communities have generally been based on ecological criteria, such as changes in biomass, diversity and in species composition, whereas genetic changes may occur in natural populations as well as aquacultured organisms exposed to pollution. Many of the pollutants found in aquatic environments are known to be genotoxic and carcinogenic, and may interact, directly with DNA or after metabolic activation [5, 6]. Genotoxicity is an organism-specific and quantitative measure of the potential of a particular environment that causes damage to a cell's DNA. Target organ genotoxicity in this context can be defined as how target organs' DNA responds to genotoxicants [3, 4].Somatic mosaicism and gonadal mosaicism as an extension of the phenomenon imply the presence of genetically different cell lines in a single organism. Our work relies on RAPD analysis to show the extend of the somatic and gonadal mosaicism in freshwater cultured *Oncorhynchus mykiss* and mari-cultured *Sparus auratus* and *Dicentrarchus labrax* to be a basement for further epigenetic and genetic work that is to be done to improve fish-culture work quality.

Materials and Methods

A comparative analysis was carried using RAPD assay to assess the genotypic differences among the same fish's various organs/tissues. Furthermore, inter and intra-tissue variations were assessed together by an improved RAPD approach proposed in this work to detect target organ genotoxic effects on various organs and tissues of aquacultured fish: *Oncorhynchus mykiss*, *Sparus auratus* and *Dicentrarchus labrax*. Genomic DNA was isolated from dissected organs of the three mentioned cultured fish. Their genetic diversity has been assessed by RAPD-PCR and intra-specific genetic variation detection due to intrinsic and extrinsic factors realized as somatic and gonadal mosaicism were shown with xn replicates of RAPD-PCR using primers OPA-8 and OPB-18. The combination of these methodologies enabled the detection of various RAPD profile changes in the DNA as a mosaicism of tissues/organs extracted separately, when the RAPD-PCR mastermix with the same organ's/tissue's DNA was aliquoted into multiple tubes and thoroughly assayed together under identical conditions.

Results and Discussion

Preliminary data obtained in this work show that the RAPD profile changes of various tissues (Figure 1, liver, muscle, gonad respectively for two different primer OPA-8 and OPB-18) of the same aquacultured fish can easily and reliably be monitored for various DNA effects described as somatic and gonadal mosaicism which might be an early indication for the heritable in the case of gonadal mosaicism and genotoxic, mutagenic and carcinogenic potentials of the cultured fish populations with variable target organ genotoxicities detected as somatic mosaicism.

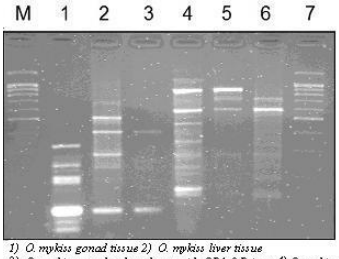


Fig. 1. Comparison of various tissue DNA mosaicism with two different 10-mer primers; OPA-8 and OPB-18.

References

1 - Atienzar F.A., Venier P., Jha A.N. and Depledge M.H., 2002. Evaluation of the Random Amplified Polymorphic DNA (RAPD) Assay for the detection of DNA damage and mutations. *Mutat. Res*., 521, 151-163.

2 - Uzonur I., Abasiyanik M.F., Bostanci B., Eyidemir M., Ocba N., Yanik C. and Petek M., Re-exploring planaria as a model organism for genotoxicity monitoring by an 'Improved Random Amplified Polymorphic DNA' approach, *Fres. Environ. Bull*., 13, 12a, 1420-1426, 2004a.

3 - Uzonur I., Abasiyanik M.F., Cam S., Cobanli K., Elmas A., Erdogan H., Hizal S., Karabulut D.S., Ozdemir M., Yesil F.A. and Petek M., A Preliminary report on target organ genotoxicity biomonitoring by an 'Improved Random Amplified Polymorphic DNA Assay'. *Fres. Environ. Bull*., 13, 12a, 1453-1456, 2004b.

4 - Uzonur I., 2005. Genotoxicity monitoring with Improved RAPD Assay on *Mytilus galloprovincialis* as a model. PhD Dissertation, Istanbul University, Institute of Marine Sciences and Management, Physical Oceanography and Marine Biology Department, Istanbul.

5 - Nadig, S. G., Lee, K. L. and Adams, S. M., 1998. Evaluating Alterations of Genetic Diversity in Sunfish Populations Exposed to Contaminants Using RAPD Assay, *Aquat Toxicol*, 43.

6 - Butovskaia, P. R., G. V. Pavlova, et al., 2009. "Somatic mosaicism in mice detected using the RAPD-PCR method." Mol Gen Mikrobiol Virusol(1): 3-7.

DENSITY AND BIOMETRY OF THE EXPLOITED HOLOTHURIAN *HOLOTHURIA TUBULOSA* AT THE DODECANESE, SOUTH AEGEAN SEA

A. M. Vafeiadou [1]*, C. Antoniadou [1], D. Vafidis [2], K. Fryganiotis [1] and C. Chintiroglou [1]
[1] Department of Zoology, School of Biology, Aristotle University, Thessaloniki, Hellas - am.vafeiadou@gmail.com
[2] Department of Ichthyology and Aquatic Environment, School of Agricultural Sciences, University of Thessaly, Nea Ionia, Magnesia, Hellas

Abstract
The edible holothurian, *Holothuria tubulosa*, was studied over a two-year period at the Dodecanese, South Aegean, in order to estimate the population density and biometry. Dense populations of the species were found at 3 islands, in shallow waters and very sheltered bays, in proximity to aquacultures. The biometric variables of the studied population differed among the islands; this pattern was linked to the trophic status of each area and the local fisheries. Considering the small size of the studied population and its low density, compared with other Mediterranean sites, it seems that *H. tubulosa* has been over-exploited at the Dodecanese.
Keywords: Density, Biometrics, Echinodermata, Aegean Sea

Introduction
The Atlanto-Mediterranean holothurian, *Holothuria tubulosa*, is among the most conspicuous benthic invertebrates in the shallow sublittoral zone [1], commonly forming dense populations in meadows and sheltered bays. It is a selective epibenthic deposit feeder, highly contributing to the recycling of bottom detritus [2]. The species is exploited in the Mediterranean, either as fishing bait or as food source [3, 4], and is currently studied for its bioactivity with promising results for the treatment of inflammatory disorders [5]. In the Aegean Sea *H. tubulosa* is harvested and utilized as fishing bait at the Dodecanese, whereas it is commercially exploited in some Turkish areas [6]. *H. tubulosa* has been well studied in the western Mediterranean and the Adriatic [2, 4, 7]. However, relevant data for the Aegean populations is missing; the existing information is limited to the geographic and bathymetric distribution of the species [1]. Taking into account the above, the aim of the present work is to contribute to the study of *H. tubulosa* population in the Dodecanese, South Aegean Sea.

Materials and Methods
The study was conducted at the Dodecanese, South Aegean Sea, where 26 stations on nine islands were randomly located (Figure 1).

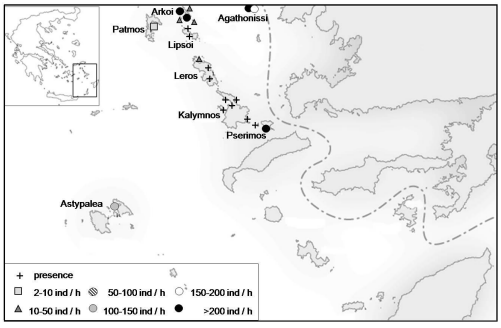


Fig. 1. Study area indicating sampling stations and relative abundance of *H. tubulosa*

Sampling, i.e. experimental fishery, was practiced by scientists and sponge fishermen by diving down to 20 m depth, in two consecutive years (2007 and 2008). 40 specimens were randomly collected from each station, in order to estimate the main biometric characteristics of the species (L = length, D = width, W = drained weight, Wg = gutted weight). Prior to biometrical analysis the specimens were relaxed in seawater containing 7.5% $MgCl_2$ at 0^oC, for 24 hours, to enhance the measurements homogeneity [8]. Population density was estimated through fishing effort, according to an index of relative abundance ranging from 1 to 7. One-way ANOVA was used to test for spatial differences for the estimated biometric variables of the species.

Results and Discussion
H. tubulosa was recorded at 18 stations, in shallow waters (less than 10 m depth) and in very sheltered bays, generally having low density (Figure 1). Dense populations were only observed at three islands: Agathonissi, Arkoi and Pserimos, where the species was found in proximity to aquacultures. A moderate dense population was also observed in Astypalea, where sampling took place in a very sheltered bay, in which organic input accumulates. These results may be explained by taking into account the oligotrophic nature of the Dodecanese area [9], which creates constraints on the holothurians feeding. As a result, the *H. tubulosa* population can thrive only in areas with high organic inputs. Moreover, in this area the species has been harvested over a long period, a fact that also precipitates the reduction of the population density.
Overall, 350 individuals of *H. tubulosa* were measured. Their size ranged from 4.13 to 19.7 cm in length and from 1.99 to 8.6 cm in width, with a mean at 10.26 ± 2.78 cm and 3.82 ± 0.88 cm, respectively. Their biomass ranged from 29.14 to 350 g for drained and from 20.3 to 164.43 g for gutted weight, with a mean at 104.59 ± 44.7 g and 61.89 ± 23.25 g, respectively. Significant spatial differences for the biometric characteristics of the species were recorded ($p<0.01$) with high values at Agathonissi and low at Pserimos.
These results can be related to differences in local environmental conditions, mainly with respect to the trophic status of each area combined also with the effect of local fisheries. Unfortunately, there is no relevant data about the fishery of *H. tubulosa*. Considering the much smaller mean size, comparing to the usual one which approximates 20-25 cm in length [3], and the low density values observed, it seems that *H. tubulosa* has been over-exploited at the Dodecanese.

References
1 - Koukouras A., Sinis A.I., Bobori D., Kazantzidis S. and Kitsos M.S., 2007. The echinoderm (Deuterostomia) fauna of the Aegean Sea, and comparison with those of the neighbouring seas. *J. Biol. Res.* 7: 67-92.
2 - Coulon P. and Jangoux M., 1993. Feeding rate and sediment reworking by the holothuroid *Holothuria tubulosa* (Echinodermata) in a Mediterranean seagrass bed off Ischia Island, Italy. *Mar. Ecol. Prog. Ser.* 92: 201-204.
3 - Tortonese E. and Vadon C., 1987. Oursins et Holothuries *In*: Fischer W., Bouchon M.L. and Scneider M. (eds), Fiches FAO d'identification des espèces pour les besoins de la pêche- Mediterranee et Mer Noire., FAO Publ., Rome, pp 743-760.
4 - Simunovic A., Piccinetti C., Bartulovic M. and Grubelic I., 2000. Distribution and abundance of the species *Holothuria tubulosa* Gmellin, 1788 and *Holothuria forskali* Delle Chiaje, 1823 (Holothuria, Echinodermata) in the Adriatic Sea. *Acta Adriat.* 41: 3-16.
5 - Herencia F., Ubeda A., Ferrandiz M.L., Terencio M.C., Alcaraz M.J., Garcia-Carrascosa M., Capaccioni R. and Paya M., 1998. Anti-inflammatory activity in mice of extracts from mediterranean marine invertebrates. *Life Scie.* 62: 115-120.
6 - Aydin M., 2008. The commercial sea cucumber fishery in Turkey. *SPC Beche de Mer Information Bulletin* 28: 40-41.
7 - Despalatovic M., Grubelic I., Simunovic A., Antolic B. and Zuljevic A., 2004. Reproductive biology of the holothurian *Holothuria tubulosa* (Echinodermata) in the Adriatic Sea. *J. Mar. Biol. Assoc. U.K.* 84: 409-414.
8 - Vafidis D., Antoniadou C. and Chintiroglou C., 2008. Population dynamics, allometric relationships and reproductive status of *Microcosmus sabatieri* (Tunicata: Ascidiacea) in the Aegean Sea. *J. Mar. Biol. Assoc. U.K.* 88: 1043-1051.
9 - Voultsiadou E., Vafidis D. and Antoniadou C., 2008. Sponges of economical interest in the Eastern Mediterranean: an assessment of diversity and population density. *J. Nat. Hist.* 42: 529-543.

FACTORS AFFECTING DISCARDING IN THE EAST MEDITERRANEAN TRAWL FISHERY

Vassiliki Vassilopoulou [1]* and John Haralabous [1]
[1] Hellenic Centre for Marine Research - celia@ath.hcmr.gr

Abstract

Analysis of data from on-site sampling of trawl fisheries in the central Aegean by observers on-board fishing vessels was conducted to determine the relative importance of certain factors (fishing and temporal) affecting discarding. A significant positive correlation was found to exist between the mean discards and the mean catch weight. Catch quantities and species composition in the catch appeared to have the highest impact on discard patterns.

Keywords: Aegean Sea, Demersal, Fisheries

Introduction

Discarding at sea occurs mainly in multi-species fisheries, such as those operated in the Mediterranean, where it is perceived mainly as throwing away unmarketable by-catch species, and/or undersized individuals of target species. In Greek waters, higher amounts of discards are generated by bottom trawlers [1], and total quantities produced annually have been estimated to range between 13,500 and 22,000 t [2]. Understanding the factors that determine what and how much is discarded is fundamental if we are to propose mitigation tools for fisheries management [3]. This study aims to contribute to the knowledge of discarding patterns and factors affecting them in east Mediterranean trawl fisheries.

Material and Methods

Data analysis was based on fishery records taken in 2004 and 2005 by observers on-board commercial trawlers on quarterly intervals except for the summer, when according to the Greek legislation trawlers operation is prohibited. All vessels were operating routinely in the central Aegean Sea and they were distinguished into two different segments on the basis of their size ($\geqslant$24m and <24m). Fieldwork at each haul comprised the recording of the fishing duration, the species composition and the total catch. Then for each species, values of both the marketable and the discarded fraction of the catch, number of fish, total weight and fish length were recorded. Haul data were subsequently aggregated at the daily trip level, mean values per fishing hour of discards and catch weight were estimated and further analysed through General Linear Model Analysis of Variance (GLM ANOVA). The dependent variable was the mean absolute values of discards per fishing hour; the fixed factors were the fleet segment, the species caught and the quarter of the year; the mean total catch per fishing hour was used as a covariate. The impact of each significant source of variation was studied through the value of partial η^2 (higher η^2 value implies higher effect).

Results and Discussion

Our results showed that on average 36.6% of the trawl catch was discarded per fishing trip. The latter value is lower than the mean discarded quantity mentioned in a previous study in Greek waters [2] and is possibly related to the implementation of the 40 mm cod-end mesh size in trawls the last few years. In the North Sea the introduction of certain technical measures which included increases to cod-end mesh size have been proven effective in reducing discards [4]. On the other hand, in the Baltic Sea cod fishery the enforcement of gear related technical measures was not successful due to poor compliance by fishers who did not accept the subsequent large short-term catch losses [5].

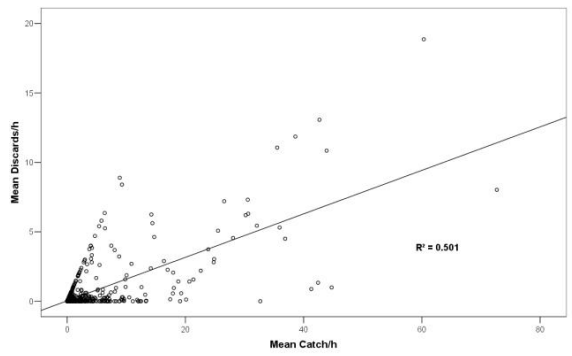


Fig. 1. Relation between mean discards and mean catch per hour (in kg) from trawlers in Central Aegean in 2004-5 by trip sampled.

Great variation appeared between mean discards and mean catch portions among trips, although a significant positive correlation ($r=0.708$, $p<0.05$) was found between the two parameters (Fig.1). Similar results were obtained in other studies [2], [6], while there were also cases where discard rates were found to be unrelated to the amount caught [7]. GLM ANOVA results revealed that the factors used in the current analysis explained about 75% of the total variability of discard quantities (Table 1). Mean catch per hour had the highest impact on discards (partial $\eta^2 = 0.418$). Concerning the main effects in the model, species had a higher impact than quarter of the year and fleet segment. Discard patterns can be highly variable and are initially affected by catch compositions, which are determined by environmental and social (regulatory, behavioural) factors, but are ultimately controlled by the fishing vessel crews, who are influenced by landing constraints and economic forces [8].

Tab. 1. GLM ANOVA results for trawl discards in the central Aegean Sea in 2004-5

Tests of Between-Subjects Effects

Dependent Variable: Mean Discards/h

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Model	1524.347[a]	117	13.029	16.572	.000	.755
species	65.375	19	3.441	4.377	.000	.117
segment	4.391	1	4.391	5.585	.018	.009
quarter	10.698	2	5.349	6.803	.001	.021
mean catch /h	355.098	1	355.098	451.666	.000	.418
species * segment	35.158	19	1.850	2.354	.001	.066
species * quarter	122.754	38	3.230	4.109	.000	.199
segment * quarter	7.909	2	3.954	5.030	.007	.016
species * segment * quarter	93.177	34	2.740	3.486	.000	.159
Error	493.732	628	.786			
Total	2018.079	745				

a. R Squared = .755 (Adjusted R Squared = .710)

References

1 - Stergiou K.I., Economou A., Papaconstantinou C., Tsimenides N. and Kavadas S., 1998. Estimates of discards in the Hellenic commercial trawl fishery. *Rapp. Comm. Int. Mer Medit.*, 35: 490–491.

2 - Machias A., Vassilopoulou V., Vatsos D., Bekas P., Kallianiotis A., Papaconstantinou C. and Tsimenides N., 2001. Bottom trawl discards in the northeastern Mediterranean Sea. *Fish. Res.*, 53: 181-195.

3 - Rochet M. J. and Trenkel V. M., 2005. Factors for the variability of discards: assumptions and field evidence. *Can. J. Fish. Aquat. Sci.*, 62: 224-235.

4 - Enever R., Revill A. S. and Grant A., 2009. Discarding in the North Sea and on the historical efficacy of gear-based technical measures in reducing discards. *Fish. Res.*, 95: 40-46.

5 - Suuronen P., Tschernij V., Jounela P., Valentinsson D. and Larsson P., 2007. Factors affecting rile compliance with mesh size regulations in the Baltic cod trawl fishery. *ICES J. Mar. Sci.* 64, 1603–1606.

6 - Evans S.M., Hunter J., Elizal E. and Wahju R.I., 1994. Composition and fate of the catch and bycatch in the Farne Deep (North Sea) *Nephrops* fishery. *ICES J. Mar. Sci.*, 51: 155–168.

7 - Tamsett D. and Janacek G., 1999. Sampling trips for measuring discards in commercial fishing based on multilevel modelling of measurements in the North Sea from NE England. *Fish. Res.*, 42: 103-115.

8 - Catchpole T. L., Frid C.L.J. and Gray T.S., 2005. Discarding in the English north-east coast *Nephrops norvegicus* fishery: the role of social and environmental factors. *Fish. Res.*, 72:45-54.

FIRST RESEARCH SIGHTINGS OF FIN WHALES (*BALAENOPTERA PHYSALUS*) IN COASTAL WATERS OF THE MALTESE ISLANDS, CENTRAL-SOUTHERN MEDITERRANEAN

Adriana Vella [1]*

[1] Conservation Biology Research Group, University of Malta - avel@cis.um.edu.mt

Abstract

Fin Whales (*Balaenoptera physalus*) have been recorded in coastal waters of the Maltese Islands for the first time between July and August 2007 during ongoing cetacean scientific surveys, at an average distance from the Maltese coasts of about 4kms and in waters of average depth of 167 meters. This first coastal Fin whales' approach, recorded as part of a long-term cetacean research, in the central-southern Mediterranean region encompassing a research area of 100,000km2, since 1997, may indicate range expansion or re-distribution of some Fin whales in the Mediterranean or a singular event. Investigating the reasons behind these approaches and planning conservation measures for such presence in high vessel traffic regions of the Mediterranean is necessary.

Keywords: Cetacea, Conservation, Coastal Waters, Monitoring

Introduction

Though Fin whales (*Balaenoptera physalus*) have been studied extensively in the North West of the Mediterranean, with a particular focus in the Ligurian Sea and in the Pelagos Cetacean Sanctuary [1,2,3,4,5], relatively fewer other Fin whale sightings and studies have been reported from elsewhere in the Mediterranean [6,7]. One such study suggests a winter feeding ground for Mediterranean Fin whales, observed close to the Island of Lampedusa in February. Here the Fin whales were observed to feed on different prey and to spend their time in shallower waters than those in the Ligurian Sea [8]. These observations were taken to suggest a seasonal shift in ecology and geographic distribution among Mediterranean Fin whales. However, the number of individuals sighted close to Lampedusa in winter was smaller than that estimated in the Ligurian sea in summer. As studies in the Ligurian Sea started to extend into the autumn and winter months it was observed that indeed the number of Fin whales decreased drastically in this region only between November and January [9]. These observations still leave questions on what may be redistributing some Fin whales while not others at different times of the year, and where such redistribution is taking place. Though various researchers reveal relationships between Fin whale distribution and environmental factors [4,5], it is still difficult to predict such distribution with synergistic impacts of increasing number of factors, including noise pollution and possible changes in climatic conditions. This would indicate the need for long-term monitoring of various regions of the Mediterranean in order to assist in the conservation management of such IUCN declared Endangered species.

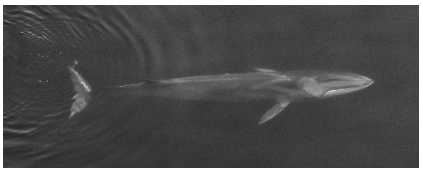


Fig. 1. Aerial photo of Fin Whale just under the water surface close to Maltese Islands

Methods

The Maltese Cetacean Research Project, ongoing in the central and southern Mediterranean Sea in an research area of 100,000Km2, around the Maltese Islands, since 1997 by the author, utilizes both aerial and marine field research surveys, to investigate cetacean abundance and distribution [10]. The Research methods adopted are those described in Vella [10]. This paper focuses on the first recorded sightings of Fin whales in coastal waters (within 5km distance from the coast) around the Maltese Islands.

Results and Discussion

A total of five Fin whale sightings were recorded in coastal waters around the Maltese Islands between July and August 2007. Out of these, four sightings in July were of single Fin whales (spotted on different days, but appeared to be the same individual residing in the same area for at least a week) and one sighting in August included two individuals (sighted once as this was followed by days with strong winds).

Cetacean projects need to focus on local to regional areas in their conservation research and management, so as to promote the long-term and dedicated year-round research and monitoring required for reliable and accurate data on these long-lives species. This first coastal Fin Whales' approach recorded in the central-southern Mediterranean region ,as part of an extensive dedicated research, may indicate range expansion or re-distribution of this species in the Mediterranean. Of course sustained research effort would allow for corroboration of these first observations. Investigating the reasons behind these approaches and planning conservation measures for such presence in high vessel traffic regions of the Mediterranean is necessary.

Tab. 1. Main observations and records linked to the first Fin whale sightings close to the coast of the Maltese islands.

Period of sightings close to Maltese Islands:	2nd week of July to 2nd week of August 2007
Average Distance from coast:	4.04 km (St. Dev = 2.09), range 2.5 to 7.5km
Average depths at sightings:	167.6 m (St. Dev = 47.71), range 85 to 200m
Other cetacean species in the area:	Common Dolphins (Delphinus delphis)
>Fishing activities in the area:	small tunas and swordfish

References

1 - Notarbartolo di Sciara, G., Venturino, M.C., Zanardelli, M., Bearzi G., Borsani, F., and Cavalloni, B., 1993 Cetaceans in the central Mediterranean Sea: Distribution and sighting frequencies. *Boll. Zool*. 60: pp131-138.

2 - Forcada, J. Aguilar, A., Hammond, P.S., Pastor, X. and Aguilar, R., 1996. Distribution and abundance of fin whales (*Balaenoptera physalus*) in the western Mediterranean during summer. *Journal of Zoology* 238, pp23-34.

3 - Beaubrun, P., David, L., Fabre, J.L. and Muller, M., 1999. Exceptional appearance of fin whales (*Balaenoptera physalus*), during the summer 1997, in the Gulf of Lion (French Mediterranean coast). Eur. Res Cetaceans (Abstracts) 13; pp162-4.

4 - Panigada, S., Zanardelli M., Mackenzie, M., Donavan, C., Melin, F., and Hammond, P.S., 2006. Modelling habitat preferences for fin whales and striped dolphins in the Pelagos Sanctuary (Western Mediterranean Sea). Abstract proceedings of the 20th annual conference of the ECS held in Gdynia Poland April 2006.

5 - Cappiello, M., Baudena, M., Nani B., and Wurtz, M., 2006. Relationship between Fin whale (*Balenoptera physalus*) and oceanographic features in the Ligurian Sea determined by GLM. Abstract proceedings of the 20th annual conference of the ECS held in Gdynia Poland April 2006.

6 - Mussi, B., Miragliulo A., Monzini E., Diaz Lopez B., and Battaglia M. 1999. Fin whale (*Balaenoptera physalus*) feeding ground in the coastal waters of Ischia (Archipelago Campano). European Research on Cetaceans (Abstracts) – 13: 92. Eds. Evans P.G.H., Cruz J., & Raga J.A. 13th Annual Conference of ECS, Valencia, Spain, 5-8 April 1999.

7 - Lipej, L., Dulcic, J., and Krystufek, B., 2004. On the occurrence of the fin whale (*Balaenoptera physalus*) in the northern Adriatic. In Journal of Marine Biological Association of the United Kingdom, 84: 861-862 Cambridge University Press.

8 - Canese S., Cardinali A., Fortuna M.C, Giusti M., Lauriano G, Salvati E. and Greco S., 2006. The first identified winter feeding ground of fin whales (*Balaenoptera physalus*) in the Mediterranean Sea. In Journal *of the Marine Biological Association of the UK* 86: pp903-907 Cambridge University Press.

9 - Laran, S. & Drouot-Dulau V., 2007. Seasonal variation of striped dolphins, fin – and sperm whales' abundance in the Ligurian Sea (Mediterranean Sea). In *Journal of Marine Biological Association of the United Kingdom*, 87: pp345-352.

10 - Vella, A., 1998. Cetacean Surveys around the Maltese Islands and Maltese Sea-User Cetacean questionnaire study. In: European Research on Cetaceans 12: (Eds. P.G.H. Evans & E.C.M. Parson) Proceedings of the 12th annual conference of the ECS, Monaco, Jan. 1998.

BLUEFIN TUNA CONSERVATION RESEARCH IN THE CENTRAL-SOUTHERN MEDITERRANEAN SPAWNING AREA

Adriana Vella [1]*

[1] Conservation Biology Research Group, University of Malta, MSD 2080, Malta, Italy - avel@cis.um.edu.mt

Abstract

Bluefin tuna (*Thunnus thynnus thynnus*) has been caught in the Maltese Islands since 1748. By 1995, when the Japanese bought bluefin tuna (BFT) caught by Maltese fishermen, the effort increased dramatically, however limited by the artisanal long-line gear used. Total BFT long-line fisheries landings have followed an over-all decline from a peak of 353,014kg in 1995 to 227,008kg in 2006. Close to 400 BFT specimens were sampled during six years to study variations in sizes, sex ratios, biogeographical characteristics and molecular genetics using microsatellite loci. This study's results indicate decreasing average BFT catch body size and an increasing sex bias for females. A significant genetic heterogeneity, FST value of 0.018 (P=0.015), was found among the BFT sampled in the spawning and fishing region south of the Maltese Islands.

Keywords: Conservation, Pelagic, Fisheries

Introduction

Tuna has been caught in the Maltese Islands with traps since 1748. However this fishing method was finally replaced with long-line, initially as a by-catch in the swordfish fisheries prior to fine-tuning gear for Bluefin tuna in 1995, when the Japanese bought Bluefin tuna caught by Maltese fishermen. Bluefin tuna fishing is now a seasonal activity for Maltese Fishermen undertaken between May and mid July. Each fishing expedition involves on average 4 days of effort with 40 to 50 miles of long-line, set at least three times, each extending down to 100m with bait which is mostly imported Mackerel. Boats utilized for this fishing measure between 10 to 26m. The increase in purse-seine fishing effort in the Central and Southern Mediterranean Area can jeopardize the survival of the species population and the livelihoods of Maltese long-line tuna fishermen if continued unchecked [1]. Vessels from Malta and Tunisia found themselves being joined by Italians, Spanish, French and recently increasing Libyan fishing vessels. The sudden increase in exclusive fishing zones by Tunisia and Libya further proves the increasing desire to increment the income from this fish species. In order to better understand the Bluefin tuna population structure and diversity found south of the Maltese islands, this study was started in 1998 [2,3] so as to undertake the microsatellite population genetics study presented here. This study has recently extended its sampling range West ward and East ward so as to expand on the results obtained so far.

Materials and Methods

Three hundred and eighty specimens of Bluefin tuna caught during the Maltese tuna long-line fishing season between 1998 and 2004 were measured (fork length and weight), sexed, and tissue sampled. DNA extraction from the stored tissues was carried out using the proteinase K/phenol/chloroform /isoamylalcohol method [4]. Microsatellite analyses protocols and primers used for this study were adapted from Takagi *et al.* [5]. PCR DNA amplification was carried out in an Eppendorf Mastercycler Gradient thermocycler. A 50ul reaction was used containing around 50ng DNA, 1μM of each primer, 5ul of buffer (consisting of 10 mM KCl, 10 mM (NH4)2SO4, 20 mM Tris-HCl, 2.0, mM MgSO4, 0.1% Triton X-100, pH8.8), 200 μM dNTPs, 3.5units of Taq DNA polymerase (New England Biolabs). 7.2ug of BSA was also added later. Each primer set had a flourescent label on either the forward or the reverse. The primers for the four loci considered included: tth01-TET; tth04-FAM; tth06-HEX; tth07-FAM. The temperature profile used involved an Initial denaturation for 5 min at 94°C, followed by 35 cycles of 1 min at 95°C, 1 min at 50°C, and 1 min at 74°C followed by a final extension of 10 min at 72°C. Allele frequencies were calculated as: number of the allele / total number of alleles (for that particular locus). Heterozygosity observed (Ho) and expected (He) were calculated using Arlequin ver.3: Ho is the number of heterozygotes observed as a ratio of the total number of individuals, while He is the expected number of heterozygotes if the total number of individuals were at Hardy-Weinberg equilibrium (HWE). Fixation index (FST) was used to measure Bluefin tuna population differentiation based on genetic polymorphism data, such as microsatellites. This statistic compared the genetic variability within and between populations. FST was calculated using Arlequin ver.3. This analysis was important in order to investigate the presence or absence of any significant differences between the various allele frequencies amongst Bluefin tuna from different sampling areas south of the Maltese Islands.

Results and Discussion

Bluefin tuna landings have increased through the years. However a decline in recent years is also noted though fishing efforts have increased. Between 1999 and 2004 on alternative years one may note a progressive increase of % females with the highest (70%) in 2004 showing a high bias toward females. Body size investigation indicates a clear reduction in the average size of the sampled individuals in 2003 and 2004. A close positive logarithmic relation between body size (kgs) and fork length (m) with a high R squared value of 0.86 was obtained. On investigating the genetic distance between samples caught during the six year study period (1999-2004) from three locations south of the Maltese Islands, genetic diversity between individuals sampled from regions A (SW of the Maltese Islands) and C (SE of Maltese islands) was found to be significant on a pairwise test: FST = 0.018 (P = 0.015). The molecular genetics analyses results for Bluefin tuna in this study show the number of alleles per microsatellite locus within samples varied from 5 for Ttho1 in the three locations to 13 for Tth07 in location B (situated between A and C). Allele richness per locus and sample varied from 3.894 at locus Tth01 in location C to 10.2 at locus Tth07 in location B. Average observed heterozygosities varied between 0.368, in location C at locus Tth01, and 0.925, in location C at locus Tth04. The expected heterozygosities varied between 0.536, in location C at locus Tth01, and 0.885 in location C at locus Tth07. The genotype distribution at loci Tth06 and Tth07 in location C deviated significantly from Hardy-Weinberg expectations (HWE) and thus were removed from subsequent analyses with the consequence that the FST value increased further in its significance.

Investigating the genetic distance between samples from the different locations South of the Maltese Islands during the six year study period (1999-2004) indicated an FST which varied from 0.018 (P=0.015) to 0.025 (P=0.012), when removing the two loci in location C found to be significantly deviating from the HWE obtained in this study. This clearly shows a significant difference between Bluefin tuna sampled in different locations in the Maltese Fishermen's fishing grounds thus requiring further conservation research and management considerations.

References

1 - Vella, A., 2002. Bluefin tuna fisheries in Central/Southern Mediterranean, around the Maltese Islands, in *Proceedings of the International Conference on Mediterranean Fisheries* – Naples 2002.

2 - Vella, A., 2006. *Blue fin tuna conservation in the Mediterranean Sea: ecology and genetic assessment in Central Mediterranean Region.* Presentation of Paper at the 1st European Conservation Biology Society Conference (Hungary – August 2006).

3 - Vella, A., 2008. Historical landings statistics, size, sex and microsatellite analyses of Bluefin tuna (*Thunnus thynnys thynnus*) in the Central-Southern Mediterranean Sea. In SCRS/2008/071 Collect. Vol. Sci. Pap. ICCAT, 63: pp161-173 (2009).

4 - Hoelzel, A. R., 1998. *Molecular Genetic Analysis Of Populations: A Practical Approach* (practical Approach Series), Oxford University Press, USA.

5 - Takagi, M., Okamura, T., Chow, S., Taniguchi, N. 1999. PCR primers for microsatellite loci in tuna species of the genus *Thunnus* and its application for population genetics study. *Fisheries Science*, 65, 571–576.

A PRELIMINARY STUDY OF THE BLUNTNOSE SIXGILL SHARK, *HEXANCHUS GRISEUS*, IN THE CENTRAL MEDITERRANEAN REGION, AROUND THE MALTESE ISLANDS

Noel Vella [1]* and Adriana Vella [1]
[1] Department of Biology, University of Malta - noel.vella@um.edu.mt

Abstract
Research on *Hexanchus griseus* (Chondritchthyans: Hexanchidae) has been ongoing since 2004, including various conservation assessments of the direct-catch fisheries and by-catch landings of this species by Maltese fishermen. Results on the number, morphometrics, sex, distribution and genetics analyses of the specimens caught allows for a long-term conservation management plan for this species and for sustainable fisheries to be set. The genetic analyses of various mitochondrial loci would determine this species' population structure.
Keywords: Elasmobranchii, Fisheries, Conservation

Introduction
Conservation risk assessments of elasmobranchs indicate that this group consists of some of the most threatened marine species, where *Hexanchus griseus* is one such case [1,2,3]. IUCN has assessed *Hexanchus griseus* as nearly threatened both on a global and regional level [4,5]. Although this species is cosmopolitan, there have been no detailed assessments on its population structure and data is scarce at the global level [4]. However records of *Hexanchus griseus* landings in Malta show that there has been a constant increase in the catches between the mid-1980s to the mid-1990s, coinciding with an increase in the fishing effort within the same period [1]. Such increase is then followed by a significant sharp decline in the catches with the average annual catches between 2004 and 2008 being that of 3917kg per year [6]. Such decline can be partially attributed to overexploitation of the areas being fished, highlighting that this slow growing shark species needs detailed dedicated research to protect the species, its habitat and sustainable fisheries depending on this resource.

Materials and Methods
This study has collected detailed records of the characteristics of this species specimens' landed since 2004. Over 435 individuals landed by fishermen at the Malta fish market were sampled till 2008. The most common fishing gear used to catch *Hexanchus griseus* is bottom longlines (97.6%), where this species is caught either as a target species or as by-catch. Statistics show that 73% of the landed *Hexanchus griseus* [6] were caught between January and April, with a peak in landings between February and March. Such seasonality is observed because during these months several fishermen exploit deep water species, but throughout the rest of the year they change the fishing gear to target more commercially important species.

Results and Discussion
The female proportion is significantly larger than that of males for the sampled individuals, which corroborates other findings [1,7,8] where similar ratios were observed on smaller sample sizes in the Mediterranean region. Analyses of the total length of the recorded specimens were also conducted. Females ranged between 74cm and 400cm, with a mean body length of 270cm (St. Dev. 63.5cm), while males ranged between 106cm and 356cm, with a mean body length of 246cm (St. Dev. 39.1cm). In this study two females (total body lengths: 397cm and 400cm) had developing ova, the latter having over 350 developing ova with a diameter between 5mm to 53mm. With regards to males, a total length of 270cm marked the point where they had either nearly or fully calcified claspers that were as long as the tip of the pelvic fin. This indicates that the size of maturity of the Central Mediterranean specimens is very similar to that observed in other Mediterranean regions [9], in which case it can be concluded that the specimens collected in this study were mostly juveniles and with only one record of a new born. No records of any gravid female have been obtained from either specimens investigated during this study nor from experience of the interviewed fishermen. This observation may indicate various regional scenarios: 1) fishing methods are targeting immature individuals, 2) mature individuals do not occur in Central Mediterranean or 3) the population has been exploited in a way that only immature specimens are left, since individuals reach sexual maturity quite late in their life-cycle.

Preliminary population genetics are giving further insight on the population structure of this exploited species within this region, so as to be in a better position to understand the status and requirements of the species and its conservation.

References
1 - Dalli J., 2004. Elasmobranchs around the Maltese Islands: field and fisheries study for conservation. Unpublished M.Sc dissertation. Faculty of Science, University of Malta, Malta.
2 - Dalli, J. and Vella, A., 2006. Elasmobranch diversity around the Maltese Islands. Presented at the MarBEF conference on Marine Research and General Assembly in Lecce, Italy. May 2006.
3 - Dalli, J. and Vella A. (*in press*) Elasmobranchs around the Maltese Islands. *In* Vella A. (ed.), Our Natural Capital: Science and Policy for Biodiversity Conservation in Malta and Europe.
4 - Cook, S.F. and Compagno, L.J.V., 2005. *Hexanchus griseus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>. Downloaded on 4 November 2009.
5 - Cavanagh R.D. and Gibson C., 2007. Overview of the Conservation Status of Cartilaginous Fishes (Chondrichthyans) in the Mediterranean Sea. IUCN, Gland, Switzerland and Malaga, Spain. vi + 42 pp.
6 - National Fisheries statistics, Department of Fisheries, Ministry of Natural Resources and Rural Affairs, Malta.
7 - Celona A., De Maddalena A. and Romeo T., 2005. *Bluntnose sixgill shark, Hexanchus griseus* (Bonnaterre, 1788), in the eastern north Sicilian waters. Bollettino del Museo civico di Storia naturale di Venezia (56): 137-151.
8 - Kabasakal H., 2008. On the occurrence of the bluntnose sixgill shark, *Hexanchus griseus* (Chondrichthyes: Hexanchidae), in the Sea of Marmara. JMBA2 - Biodiversity Records, 1-5.
9 - Capapé C., Hemida F., Guélorget O., Barrull J., Mate I., Ben Souissi J. and Bradaï M.N., 2004. Reproductive biology of the bluntnose sixgill shark *Hexanchus griseus* (Bonnaterre, 1788) (Chondrichthyes: Hexanchidae) from the Mediterranean Sea: a review. *Acta Adriatica* 45 (1): 95-106.

DO THE TECHNICAL CHARACTERISTICS OF THE TRAWLERS CONTROL BOTTOM TRAWLING ACTIVITY IN THE GULF OF GABES (TUNISIA)?

M. Verdoit-Jarraya [1]*, S. Mosbah [1], M. Ghorbel [2], O. Jarboui [2] and P. Lenfant [1]
[1] UMR 5244 CNRS-EPHE-UPVD Biologie et Ecologie tropicale et méditerranéenne - marion.jarraya@univ-perp.fr
[2] INSTM, Sfax, Tunisie

Abstract
In the Gulf of Gabès, bottom trawling is a highly developed fishery but is still poorly known. The aim of this study was to identify this fishery by determining the technical characteristics of the trawlers, their production, fishing area and target species, using a typological approach based on multivariate analyses of landings data. Four fishing strategies are defined (caramote prawn and fish fishery, fishery of the species destined for exportation -essentially rose shrimp- and non selective fisheries) showing that differences in fishing tactics are mainly due to differences of exploited areas which depend themselves on the technical characteristics of the vessels.
Keywords: Fisheries, Gulf Of Gabes, Coastal Management, Gis, Analytical Methods

Introduction
The Gulf of Gabès is the most important fishing area in Tunisia (south-western Mediterranean Sea) and bottom trawling is the most predominant fishing activity in this area. Fisheries management not only requires the knowledge of the biological and the dynamics parameters of the resources but also to identify the characteristics of the fleets. Many authors have tried to establish a typology of the trawling activity ([1], [2],[3]), but in this region, it is still poorly known. The purpose of this study is to identify the effects of the technical characteristics of the fleets and the prospected areas on the trawlers productions.

Material and methods
Two data sets were available: one from national statistics of Tunisia, and the other one from individual on-site interviews of the trawlers captains in the Sfax harbour. The data were collected during 3 months from February to April 2008, and were related to the technical characteristics of the boats. The quantity of the species caught was also estimated. A typology of the fleet was used to identify several metier (a gear associated with a fishing practice) to explore potential relationships between the technical characteristics of the trawlers and the species caught. The methodology employed to reach theses objectives consist in multivariate data analyses which are more and more employed in the fisheries sciences ([4],[5]). Cartographic representations of the metiers were also performed using a Geographical Information System (G.I.S).

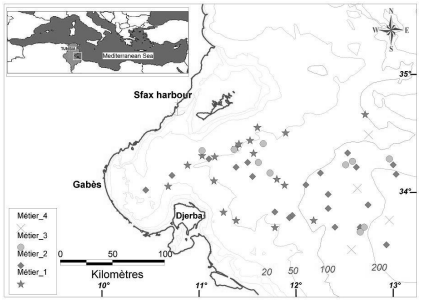


Fig. 1. Activity areas of the different trawler groups operating in the gulf of Gabès

Results and Discussion
Fleet structure and eploited species.: The data collected by the Statistical Service of the General Direction of Fishing and Aquaculture show an increase of engine power of the trawlers (and indirectly of fishing effort) in the lasts decades.A total of 88 trawlers were prospected (33% of the trawlers of the area). The average total length, GTR and engine power were estimated and the main exploited species were characterised. *Typology of the active fleet and activity areas of each métier.* The typological analysis of the trawlers showed the existence of 4 fishing strategies (métier) (Table 1) and the activity areas of the trawlers for each metier were represented using a GI.S.(Fig. 1). The first target caramote prawn and cuttlefish. This métier is practiced by old trawlers with low engine power and low autonomy at sea. The second métier is composed by the youngest and less selective trawlers; involving an important number of sailors. The third is fish fishing. The units belonging to this group have the best technical characteristics (big boats with highest engine power and gross tonnage) and operate at deep sea and their interest is to prolong duration of the outing to take advantage of the trip. The fourth métier is fishing for export (species like rose shrimp, common octopus, musky octopus, and european squid). The units linked to this activity are the longest trawlers with an important crew number. They are the freezer trawlers. This type of activity requests big units and an important number of sailors to carry out the operations of sorting, conservation and packaging of the species caught. It is a new fishery and results from diverse economic (poor profitability of the traditional fisheries) and biological factors (weak fish production due to over exploitation of the stocks).

Tab. 1. Description of the four métiers in regard with the technical characteristics of the boats and the landed species

		characteristics						
Métier	Num-ber	Test value	Nominal variable	Test value	Species	Test value	Technical variable
1	26	6.09	01: EP< 400 HP	6.06	Common cuttlefish	2.61	Trawler age
		-2.38	03 EP: [600-800]HP	4.59	Caramote prawn	-3.19	Numbre day in haul
				-2.99	Rose shrimp	-4.78	Crew number
				-4.82	Fish	-4.85	Lenght
						-5.89	Gross tonnage
						-6.19	Engine power
2	40	4.33	02 EP: [400-500]HP	-2.36	European squid	2.37	Crew number
		-4.35	01: EP< 400 HP	-2.75	Caramote prawn	-2.76	Trawler age
				-3.58	Common cuttlefish	-2.84	Travel number
3	12	4.04	04: EP> 800 HP	5.90	Fish	5.37	Lenght
		-3.00	03 : EP: [500-600]HP			4.92	Engine power
						3.82	Gross tonnage
						3.30	Commander age
						2.38	Numbre day in haul
4	6			8.43	European squid	3.99	Numbre day in haul
				4.44	Rose shrimp	3.16	Crew number
				3.24	Musky octopus	2.63	Lenght
				3.12	Common octopus		

Conclusion
This study indicates that the technical characteristics of vessels command the fisheries strategies and therefore the exploited species. The role of the technical parameters in the identification of the different métier has not been mentioned in the national studies implying a typology of the trawlers. The most mentioned factors are the seasonality ([6]) and the fishing zone ([7]). The results of the two approach (cartographic and statistic) show a good concordance, might be a good basis for the management of the fishing activity in the gulf of Gabès.

References
1 - Taquet M., Gaertner J.C., Bertrarid J., 1997, Typologie de la flottille chalutière du port de Sète par une méthode de segmentation. *Aquat. Living Resour*. 10, 137 – 148.
2 - Jiménez M.P., Sobrino I., Ramos F., 2004, Objective methods for defining mixed-species trawl fisheries in Spanish waters of the Gulf of Cádiz. *Fish. Res*. 67, 195–206.
3 - Campos A., Fonseca P., Fonseca T., Parente J., 2007, Definition of fleet components in the Portuguese bottom trawl fishery. *Fish. Res*. 83, 185 – 191.
4 - Pelletier D., Ferraris J., 2000, A multivariate approach for defining fishing tactics from commercial catch and effort data. *Can. J. Fish. Aquat. Sci*. 57 (1), 51 – 65.
5 - Verdoit M., Pelletier D., Bellail R., 2003, Are commercial logbook and scientific CPUE data useful for characterizing the spatial and seasonal distribution of exploited populations? The case of the Celtic Sea whiting. *Aquat. Living Resour*. 16, 467 – 485.
6 - Missaoui H., Jabeur Ch., Gobert B., Jarboui O., Elabed A., 2000, Analyse typologique de la flottille chalutière du golfe de Gabès (Sud Est Tunisie). *Bull. Inst. Scien. Tech. Mer* Salammbô 27, 15 – 26.
7 - Abdesselem F., M'Timet M., Jarboui O., 1998, La pêche au chalut benthique sur les côtes nord de la Tunisie. Cah. Option Mediterr. 301 – 308.

SEA WATER PILING: TRADITIONAL OR ALTERNATIVE MATERIALS? AN INTEGRATED BIOLOGICAL AND ECOTOXICOLOGICAL EVALUATION IN VENICE LAGOON (ITALY)

A. Volpi Ghirardini [1], C. Losso [1], G. Libralato [1]*, M. Zanella [1], E. Keppel [2], M. Sigovini [2] and D. Tagliapietra [2]
[1] Environmental Sciences Department, University of Venice, Campo della Celestia 2737/b, 30122, Venice, Italy - giovanni.libralato@unive.it
[2] Consiglio Nazionale delle Ricerche, Istituto di Scienze Marine, Riva Sette Martiri, 1364/a, I-30122 Venice, Italy

Abstract
Wood has been traditionally used as piling material in estuarine and marine coastlines. Recently, in Venice lagoon, timbers turn-over accelerated not only due to water mechanical action, but also to the increase of their biological degradation operated by wood borers. The need to guarantee navigation safety and increase environment protection determined the identification of a series of traditional add-ins and alternative piling materials. The aim of this study was to verify through some *in situ* and *ex situ* experiments the ecotoxicological viability of the proposed piling materials as well as to fill the gaps in the knowledge about the distribution and ecology of the main species of wood boring invertebrates in order to supply policymakers and stakeholders with a series of scientific criteria to manage the timbers turn-over phenomenon.
Keywords: Bio-Accumulation, Ecotoxicology, Lagoons

Large amounts of wood have been used over the centuries for piles, docks and bulkheads for developing estuarine and coastal areas. Wood is a particularly useful building material as it is a renewable resource, with relatively low harvesting costs and excellent strength-to-weight properties [1]. Timbers for piling purposes are frequently treated in order to retard or prevent decay due to wood-boring organisms such as fungi, molluscs and crustaceans [2]. Recently, in Europe traditional timber species started to be substituted not only by tropical ones, but also by a wide series of treated wooden-based materials as well as completely artificial ones. Indeed, they are supposed to be more resistant to water mechanical action and wood-boring agents, lowering the related management costs, but with unknown environmental implications. In Venice Lagoon, wood is extensively used for maritime works, especially mooring piles and navigation channel marks (named "briccole") (approximately 7,000). In addition to the degradation caused by natural and man-made physical factors, timbers are characterized by strong biotic degradation phenomena. It has been estimated that along the shipping channels there are about 22,000 wooden piles constituting the briccole and between 5,000 and 10,000 wooden piles are present for boats mooring. Each year, a large number of them must be replaced. Recently, it was observed that their turn-over increased, probably as a consequence of a higher biological activity of marine wood borers such as the molluscs Bankia carinata, Lyrodus pedicellatus, Nototeredo norvegica and Teredo navalis, the isopods Limnoria lignorum and L. tripunctata and the amphipod Chelura terebrans. The problem of protecting wooden constructions in the Lagoon is of considerable interest mainly for navigation safety and environment protection as well as under the economical viewpoint. Various solutions were suggested such as the use of high durability essences, the application of physico-chemical protections or the opportunity to take into consideration alternative materials (e.g. plastics or recycled plastics). The aim of the currently ongoing research study is to assess a discrete set of piling materials (n = 16) in order to verify their durability towards mechanical water stress, their sea water ecotoxicity and the potentiality for wooden ones to be biologically degraded, considering both in situ and ex situ experimental activities.

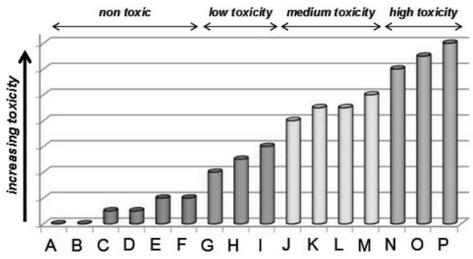


Fig. 1. The investigated piling materials (# 16) present leachates with various toxicity levels towards saltwater biota.

In situ experiments have been set up to obtain bioaccumulation data from active and passive biomonitoring using mussel exposure, to characterize and evaluate the intensity of wood borers attacks on lagoon scale, to define a preliminary model of habitat suitability and to increase the ecological knowledge of the main species of wood boring invertebrates. Ex situ activities have been scheduled to assess the potential ecotoxicological hazard of leachates generated by piling materials under various exposure conditions considering a battery of sensitive seawater toxicity testing species (i.e. bacteria, algae, molluscs and crustaceans). The final aim is to supply policymakers and stakeholders with a series of scientific criteria in order to manage the phenomenon of timbers turn-over and, specifically, to compare the usage of traditional and alternative piling materials as well as other protective add-ins.

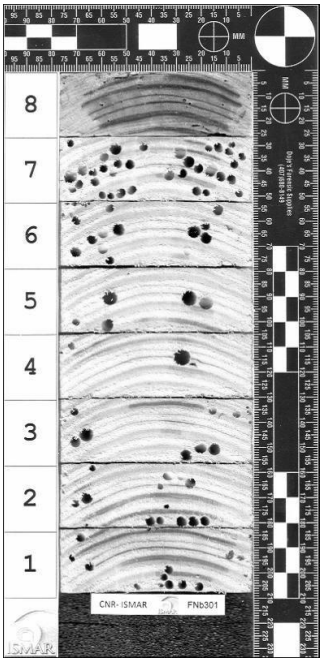


Fig. 2. Galleries produced by the teredinids from one of the test wood blocks installed in the Venice lagoon (Italy).

Acknowledgements: This work was granted by the Water Authority of Venice (Magistrato alle Acque di Venezia) through its concessionaire Consorzio Venezia Nuova.

References
1 - Eaton R.A. and Hale M.D.C., 1993. Wood: decay, pests and protection. Chapman and Hall (ed.), London.
2 - Libralato G., Losso C. and Volpi Ghirardini A., 2007. Toxicity of untreated wood leachates towards two saltwater organisms (*Crassostrea gigas* and *Artemia franciscana*). *J. Haz. Mat.*, 144: 590-593.

BATH SPONGES FROM A MARINE PROTECTED AREA IN THE AEGEAN SEA

E. Voultsiadou [1]*, C. Antoniadou [1], T. Dailianis [1], D. Vafidis [2] and C. Dounas [3]
[1] Department of Zoology, School of Biology, Aristotle University, Thessaloniki, Greece - elvoults@bio.auth.gr
[2] Department of Ichthyology and Aquatic Environment, University of Thessaly, Nea Ionia, Magnesia, Greece
[3] Institute of Marine Biology & Genetics, Hellenic Centre for Marine Research, Heraklion, Crete, Greece

Abstract
Diversity and density of bath sponges have been investigated in eleven localities inside and outside the area of the National Marine Park of Alonissos and Northern Sporades (NMPANS). The species *Hippospongia communis* (Lamarck, 1814) and *Spongia officinalis* (Linnaeus, 1759) were recorded. Dense populations of the latter, consisting of moderate-sized individuals, were detected exclusively in the core of the Marine Protected Area (MPA). Considering the dramatic decline of Mediterranean commercial sponge populations during the last 20 years, due to the combined effects of successive disease outbreaks and unregulated fishing activities, the remarkable sponge abundance recorded suggests that protection conditions may be considerably in favour of the viability of sponge populations.
Keywords: Porifera, Sporades Islands, Marine Parks, Density, Conservation

Introduction
Five sponge species of the family Spongiidae have been traditionally harvested in the Mediterranean Sea ([1]). During the last decades periodic disease outbreaks have decimated their natural populations ([2]) and along with unregulated harvesting have caused a severe decline in bath sponges catch. In Greece, a large area of the north Aegean, covering 2.220 km^2, has been assigned as a Marine Park since 1992, constituting the largest MPA in the Mediterranean Sea ([3]). Before the imposition of the protective measures, the area was regularly exploited by sponge fishermen, while afterwards only sporadic, unauthorized harvesting of bath sponges occurred, mostly outside the core of protection.

Materials and Methods
The study was conducted in summer 2008, at 7 stations set inside the established Marine Park and 4 stations in adjacent unprotected areas (Figure 1). Sponge population density was estimated by scientists accompanied by sponge fishermen diving down to 50 m, as the number of individuals encountered per length of investigated area (N/km). In total 130 randomly selected sponge individuals were measured for their dimensions in three axes and their product was used to estimate sponge size in liters.

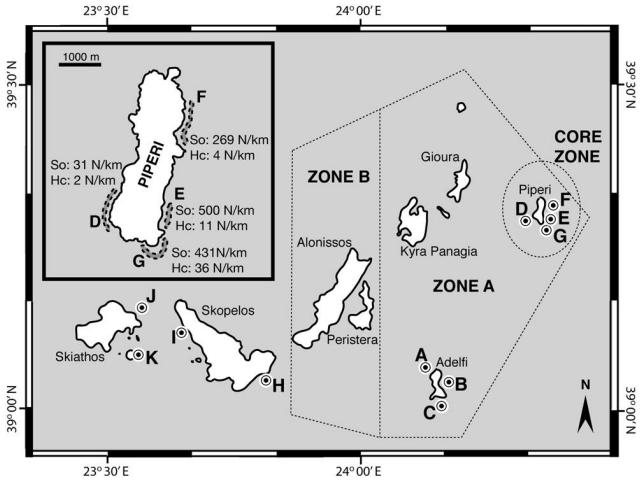


Fig. 1. Study area indicating sampling stations and estimated population density of sponge species (So: *S. officinalis*, Hc: *H. communis*)

Results and Discussion
The two most common Mediterranean bath sponge species, *H. communis* and *S. officinalis*, were recorded exclusively inside the core area of the Marine Park on rocky bottoms and *Posidonia*meadows; the former in low abundances, and the latter with dense populations at most occasions (Figure 1). *S. officinalis* varied in size from 0.27 to 7.2 liters, and its population consisted mostly of moderate-sized individuals. The size of *H. communis* individuals varied from 1.6 to 21.2 liters, exhibiting a wider range of size distribution due to the presence of few large-sized individuals (Figure 2).

Although preliminary, the present data suggest that protection measures may be considerably in favour of the viability of sponge populations which thrive inside the MPA, in contradiction with the unprotected areas surveyed in this study as well as other Aegean areas open to uncontrolled sponge fishery ([4]). In other Mediterranean areas over-exploitation and disease incidences have also led to a decreasing trend in sponge abundance and size ([1]), while recovery was observed in MPAs ([5]). However, the low population density values in one studied station of the core area and the complete absence of the two species from other stations in protection zone A suggest that the protection scheme *per se* cannot safeguard the existence and robustness of commercial sponge populations. The systematic comparison of sponge communities between protected and unregulated areas, as well as the investigation of the particular environmental conditions in the North Sporades Archipelago will further elucidate the reasons of these findings.

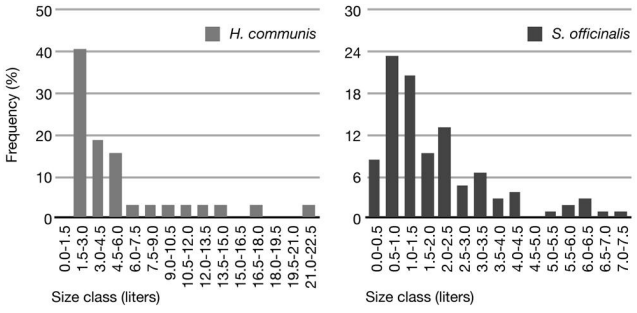


Fig. 2. Size frequency distribution of the studied populations of sponge species

Acknowledgments : This research was supported by the Greek Ministry of Rural Development and Food (EPAL 2006-2008). We are grateful to the Management Body of the NMPANS, as well as to the crew of the sponge fishing vessel ''Cap. Giorgos'' for their help.

References
1 - Pronzato R. and Manconi R., 2008. Mediterranean commercial sponges: over 5000 years of natural history and cultural heritage. *Mar. Ecol.*, 29: 146-166.
2 - Webster N.S., 2007. Sponge disease: a global threat? *Environ. Microbiology*, 9(6): 1363-1375.
3 - Badalamenti F., Ramos A.A., Voultsiadou E., Sanchez Lizaso J.L., D'Anna G., Pipitone C., Mas J., RuizFernandez J.A., Whitmarsh D. and Riggio S., 2000. Cultural and socio-economic impacts of Mediterranean marine protected areas. *Environ. Conserv.*, 27: 110-125.
4 - Voultsiadou E., Antoniadou C., and Vafidis D. 2008. Sponges of economical interest in the Eastern Mediterranean: an assessment of diversity and population density. *J. Nat. Hist.*, 42: 529-543.
5 - Perez T. and Capo S., 2001. Eponges commerciales du Park National de Port-Cros : estimation de la densité de deux populations de *Spongia officinalis* (Linne, 1759). *Sci. Rep. Port-Cros natl. Park, Fr.*, 18: 143-148.

POPULATION STRUCTURING OF *CALANUS HELGOLANDICUS S.L.* IN EUROPEAN WATERS

L. Yebra [1]*, D. Bonnet [2], R. P. Harris [3], P. K. Lindeque [3] and K. T. Peijnenburg [4]

[1] Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Apdo. 285, 29640 Fuengirola, Málaga, Spain - lidia.yebra@ma.ieo.es

[2] Ecosystèmes lagunaires, Unité mixte de recherche CNRS-UMII 5119, Université Montpellier II, Place Eugène Bataillon, Case Courrier 093, 34095 Montpellier Cedex 5, France

[3] Plymouth Marine Laboratory, Prospect Place, Plymouth, PL1 3DH, UK

[4] Marine Biodiversity, Ecology and Evolution, UCD School of Biology and Environmental Science, Science and Education Research Centre (West), University College Dublin, Belfield, Dublin 4, Republic of Ireland

Abstract

Calanus helgolandicus s.l. genetic differences have been identified for the first time between and within European basins, as well as a decrease of prosome length with latitude. Our study explores the population structuring of this key species in relation to morphology, genetics and hydrography.

Keywords: Copepoda, Biogeography, Hydrography, Genetics

The marine copepod *Calanus helgolandicus* is of considerable importance in the marine food web. It plays a critical role in marine ecosystems as a grazer of microplankton and as a major food source for commercially important fish. The distribution of *C. helgolandicus* in European waters covers a wide range of habitats, from open ocean to coastal environments. Recent studies [1, 2] have shown that *C. helgolandicus* is sensitive to changes in climate. Its distribution range and abundance has increased as European waters have warmed over recent decades. Building on the network of laboratories created by *Bonnet et al*. for their review on *C. helgolandicus* (2005), we collected samples in 95% ethanol from 19 European sites (figure 1).

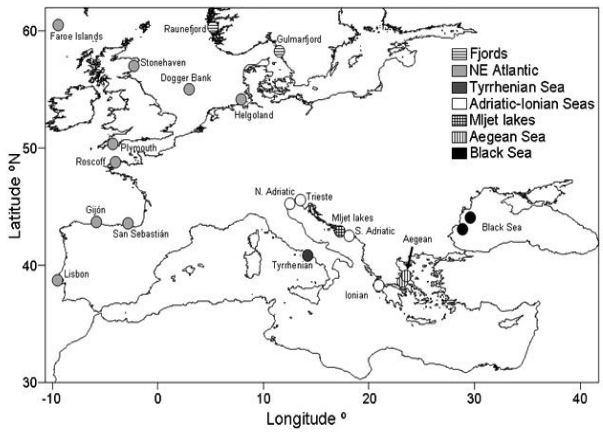


Fig. 1. Map of the stations. Different shades indicate different genetic regions: Fjords, NE Atlantic, Tyrrhenian Sea, Adriactic and Ionian Seas, Mljet lakes, Aegean Sea, Black Sea

To reveal barriers to dispersal within this species' distribution range (including the closely related *C. euxinus* from the Black Sea) we compared morphological (prosome and urosome length) and genetic (mitochondrial 16S rDNA gene) structuring of populations and linked these with sea surface temperature and other hydrographic features. *Calanus* populations showed high levels of genetic diversity and strong population genetic structuring with six major groupings: (1) NE Atlantic and Tyrrhenian Sea, including the subgroup (2) northern fjords, (3) Eastern Mediterranean, which contained subgroups (4) seawater lakes of Mljet island in the Adriatic Sea and (5) Aegean Sea, and (6) Black Sea. Morphological structuring is congruent with the genetic groupings within the E Mediterranean. However, groupings differed within the Atlantic, where latitude (i.e. temperature) appears to affect morphology more than gene flow. *Calanus* populations from the Mljet lakes, Aegean Sea and Black Sea are isolated at the genetic, morphological and hydrographical levels and might represent incipient species.

Acknowledgements : Authors are indebted to A. Albaina, J. Cabal, K. Cook, R. Diekman, A. Dos Santos, E. Gaard, S.H. Jonasdottir, L. Kamburska, D. Lucic, M.G. Mazzocchi, J.C. Nejstgaard, S. Poulet, A. Ramfos, P. Thor and V. Tirelli for supplying *Calanus helgolandicus* specimens. We thank P. Pickerill for his sequencing of the samples, D. Conway for his help in sorting and identifying *C. helgolandicus* from the various samples received, and L. Blanco-Bercial and A. Bucklin for their comments on the early manuscript. This work was undertaken while L.Yebra and D. Bonnet were at the Zooplankton Group at Plymouth Marine Laboratory (PML). This work is a contribution to the PML Core Strategic Programme.

References

1 - Bonnet D., Richardson A., Harris R.P., Hirst A.G., Beaugrand G., Edwards M., Ceballos S., Diekman R., Lopez-Urrutia A., Valdes L., Carlotti F., Molinero J.C., Weikert H., Greve W., Lucic D., Albaina A., Yahia D.N., Fonda Umani S., Miranda A., Dos Santos A., Cook K., Robinson S. and Fernandez Puelles M.L., 2005. An overview of *Calanus helgolandicus* ecology in European waters. *Prog. Oceanogr*., 65: 1-53.

2 - Reid P.C., Edwards M., Beaugrand G., Skogen M. and Stevens D., 2003. Periodic changes in the zooplankton of the North Sea during the twentieth century linked to oceanic inflow. *Fish. Oceanogr*., 12: 260-269.

DIET OF THORNBACK RAY (*RAJA CLAVATA* LINNAEUS, 1758) IN SAROS BAY (THE NORTH AEGEAN SEA)

Cigdem Yigin [1]* and Ali Ismen [1]

[1] Çanakkale Onsekiz Mart University, Fisheries Faculty, Department of Fishing and Processing Technolog - cyigin@hotmail.com

Abstract

Food composition of thornback ray (*Raja clavata*) was studied in Saros Bay (North Aegean Sea). A total of 121 thornback ray were caught and examined. Stomach samples from 68 females (10,7-88 cm TL) and 53 males (14-76 cm TL) were examined. Of the stomachs examined, 116 (96%) were full and 5 (4%) empty. A total of 511 prey items, belonging to 6 prey taxa, were counted. Crustacea were the most important component in the diet of *R. clavata* with IRI% of 74.78. Other main prey items found in the stomachs were pisces (IRI%=18.59),nematoda (IRI%=5.98),cephalopoda (IRI%=0.08),annelida (IRI%=0.03) and mollusca (IRI% =0.01).

Keywords: Diet, Elasmobranchii, Aegean Sea

Introduction

Elasmobranch fishes are among the top predators in the marine environment and thus play an important role in marine ecosystems, potentially regulating, through predation, the size and dynamics of their prey populations [4].The aim of this study was to examine the feeding habits of thornback ray caught in Saros Bay (The North Aegean Sea).

Tab. 1. List of the species identified in *R.clavata* stomach contents

SPECIES	%N	%W	%F	%IRI
ANNELIDA				
Unidentified polychaeta	0.40	0.82	0.90	0.03
NEMATODA				
Unidentified nematoda	10.80	0.03	19.00	5.98
MOLLUSCA				
Unidentified gastropoda	0.20	0.02	0.90	0.01
CEPHALOPODA				
Eledone moschata	0.20	0.07	0.90	0.01
Loligo sp.	0.40	1.08	1.70	0.07
Total	0.60	1.15	2.60	**0.08**
CRUSTACEA				
Isopoda				
Cymotoid parazitic isopod	1.80	0.12	2.60	0.14
Unidentified isopod	0.60	0.05	1.70	0.03
Decapoda				
Unidentified decapod	0.20	0.00	0.90	0.01
Natantia				
Alpheus glaber	1.00	0.45	3.40	0.14
Crangonidae	0.20	0.03	0.90	0.01
Caridea	1.80	0.39	6.00	0.38
Solenocera membranacea	1.00	0.42	3.40	0.14
Plesionika sp.	1.20	0.36	4.30	0.19
Plesionika giglioli	0.40	0.19	1.70	0.03
Parapenaus longirostris	5.10	3.97	16.40	4.34
Processa sp.	0.40	0.04	1.70	0.02
Unidentified natantia	1.20	0.15	4.30	0.17
Processa nouveli	0.20	0.01	0.90	0.01
Aegean cataphractus	0.20	0.02	0.90	0.01
Pasiphaea sivado	0.20	0.01	0.90	0.01
Trachypenaeus curvirostris	0.80	0.21	1.70	0.05
Anomura				
Galetea bolivari	0.40	0.01	0.90	0.01
Munida sp.	0.40	0.04	0.90	0.01
Macrura Reptantia				
Unidentified thallasinidae	0.20	0.06	0.90	0.01
Scyllarus sp.	0.40	0.16	1.70	0.03
Stomatopoda				
Squilla mantis	0.80	3.94	3.40	0.48
Brachyura				
Unidentified brachyura	1.20	1.46	4.30	0.33
Liocarcinus depurator	3.90	3.47	10.30	2.23
Goneplax rhomboides	36.80	14.65	43.10	64.81
Athelecyclus roduntatus	2.70	1.05	4.30	0.48
Eballa sp.	0.20	0.47	0.90	0.02
Liocarcinus pusillus	0.20	0.13	0.90	0.01
Eballa granulosa	0.20	0.22	0.90	0.01
Monodeus couchii	2.20	0.42	6.90	0.52
Anapagurus laevis	1.00	0.53	0.90	0.04
Megalopa larvasi	1.20	0.00	0.90	0.03
Medorippe lanata	0.20	0.08	0.90	0.01
Microcaslope minor	1.00	0.34	1.70	0.07
Total	69.30	33.45	135.50	**74.78**
PISCES				
Mullus barbatus barbatus	5.30	31.95	12.90	14.07
Pagellus bogaraveo	1.00	5.02	4.30	0.76
Merluccius merluccius	1.00	7.50	3.40	0.85
Serranus hepatus	0.60	1.77	2.60	0.18
Pagellus acarne	0.20	0.89	0.90	0.03
Arnoglossus laterna	0.20	1.33	0.90	0.04
Spicara smaris	0.40	2.28	1.70	0.13
Engraulis encrasicholus	5.90	7.89	2.60	1.04
Gaidculus argenteus argenteus	0.40	0.62	0.90	0.03
Symphurus nigrescens	0.20	0.85	0.90	0.03
Unidentified fish	2.20	4.17	7.80	1.43
Total	17.40	64.27	38.90	**18.59**
DIGESTED MATERIAL	2.00	0.29	8.60	0.57

Material and Methods

Specimens were collected by using commercial trawl between February 2005 and December 2006 in the Saros Bay. The trawling was done daytime and nighttime at depths ranging from 0 to 500 m. In the laboratory, identification of ingested prey was carried out to the level of species.Stomach content was analyzed using the percentage frequency of occurrence (F%), numerical percentage (N%), percentage by weight (W%), the index of relative importance (IRI), and percent of IRI (IRI%) for each prey type [1,2].

Results

Stomach samples from 68 females (10.7-88 cm TL) and 53 males (14-76 cm TL) were examined. Of the 121 stomachs examined, 116 (96%) were full and 5 (4%) empty. A total of 511 prey individuals was identified (Table 1), crustacea were the most important component in the diet of *R. clavata* with IRI% of 74.78. Pisces were second in importance, IRI% of 18.59. Besides nematoda,cephalopoda,annelida and mollusca with IRI% of 5.98, 0.08, 0.03 and 0.01 respectively were minor prey. As compared with IRI% values between sexes, there were not significantly difference in composition of the diet of male and female thornback rays (P = 0.801).

Discussion

The nature of the ingested food depends, first on the morphology and feeding behavior of the fish, and secondly, on the composition and amount of food available.The flat body and ventral mouth of the skates suggest a benthic feeding habit [3]. In this study, the results demonstrated that *R. clavata* feed on benthic prey items, variations in the Index of Relative Importance (IRI%) among the prey groups showed that crustaceans were the most important component in the thornback ray.

References

1 - Cortés E., 1997. A critical review of methods of studying fish feeding based on analysis of stomach contents: application to elasmobranch fishes. *Can. J. Fish. Aquat. Sci*. 54: 726-738.

2 - Hyslop E.J., 1980. Stomach content analysis – a review of methods and their application. *J. Fish. Biol*. 17, 411-429.

3 - Moyle, P.B. and Cech-Jr. J. J., 2004. Fishes: An Introduction to Ichthyology - fifth edition. Upper Saddle River, NJ: Prentice-Hall, Inc.

4 - Navia A.F., Mejía-Falla P.A. and Giraldo A., 2007. Feeding ecology of elasmobranch fishes in coastal waters of the Colombian Eastern Tropical Pacific. *BMC Ecology*, 7:8,1-10.

RAPID EXPANSION OF RECENTLY INTRODUCED SPECIES POPULATIONS OFF THE MEDITERRANEAN COAST OF TURKEY

M. B. Yokes [1]*, M. Goren [2], S. Ü. Karhan [3], V. Demir [4], E. Kalkan [5], B. S Galil [6] and A. Diamant [6]
[1] Department of Molecular Biology & Genetics, Halic University - bakiyokes@halic.edu.tr
[2] Department of Zoology, Tel Aviv University
[3] Department of Biology, Istanbul University
[4] Institute of Marine Sciences and Management, Istanbul University
[5] Department of Environmental Science, Bogaziçi University
[6] National Institute of Oceanography, Israel Oceanographic and Limnological Research

Abstract

Recent surveys along the Mediterranean coast of Turkey have documented the rapid expansion of populations of tropical alien species such as *Amphisorus hemprichii, Percnon gibbesi, Aplysia dactylomela, Septifer forskali, Diadema setosum, Apogon smithii, Apogon quecketii, Nemipterus randalli* and *Vanderhorstia mertensi*.
Keywords: Eastern Mediterranean, Fishes, Mollusca, Foraminifera, Crustacea

The sublittoral macrofauna of the Mediterranean coast of Turkey was studied in May 2008 and July 2009. Eight bottom trawling sessions were performed at depth of 20-off Iskenderun and Antalya. The population increase of *Apogon smithii*, and *Nemipterus randalli* were noteworthy (Table 1). The Red Sea cardinal fish *A. smithii* was first recorded from Turkey during this study and seven individuals were collected in Iskenderun Bay in 2008 [1], which constituted only 0.003 % of the total biomass. A year later, its percentage increased almost hundred fold (0.29 %). Although an increase was observed also in the populations of *A. quecketii*, it was not significant, indicating that these *Apogon* spp. may have different ecological characteristics. An even more dramatic expansion was observed in the Indian Ocean threadfin bream *N. randalli.* In 2008, it constituted 0.01 % of the total biomass in Iskenderun Bay, whereas in 2009 it was already 1.86 %. A lesser but still prominent increase was observed in Antalya (0.02 % in 2008 vs 1.1% in 2009).

Tab. 1. Biomass percentage of the species observed in 2008 and 2009

	Iskenderun		Antalya	
	2008	2009	2008	2009
Apogon smithii	0,003	0,29	-	-
Apogon quecketii	0,03	0,04	-	-
Nemipterus randali	0,01	1,86	0,02	1,1

In the framework of a marine biodiversity project, 113 stations off Kas (Antalya) have been regularly monitored by SCUBA diving from June 2002 to August 2009. 15 alien species have been recorded [2-6]. The populations of the foraminiferan *Amphisorus hemprichii*,brachyuran crab *Percnon gibbesi*,, sea hare *Aplysia dactylomela*, bivalve *Septifer forskali* and the slender shrimpgoby *Vanderhorstia mertensi* expanded remarkably. Both population density and their occurrence increased significantly (Table 2). *Amphisorus hemprichii* has been first recorded in the Mediterranean from 21 stations off Kas in 2002 [5]. One year later it spread to all 113 stations, and was found off Bodrum and Datça in the Aegean Sea as well.At present, the species occurs from Antalya to Bodrum on the southwestern coast of Turkey. Five years after it was first reported in Iskenderun Bay, *Septifer forskali* reached Antalya Where it was recorded in four stations in 2006, 84 stations the next year and 113 stations two years later. in the populations of *Percnon gibbesi, Aplysia dactylomela* and *Vanderhorstia mertensi* expanded as well, but since these species need specific habitat types, they cannot inhabit all the sampling sites. However, the stations in which they are observed cover the entire region, indicating that these species also successfully invaded southwestern coast of Turkey. Not all alien species are invasive: two individuals of the needle-spined urchin *Diadema setosum* have been recorded off Kas in 2006 [3], but no other specimen was sighted since.

Tab. 2. The number of stations off Kas where alien species were observed 2002 - 2009

	Number of stations							
	2002	2003	2004	2005	2006	2007	2008	2009
Amphisorus hemprichii	21	113	113	113	113	113	113	113
Percnon gibbesi	0	0	0	0	2	3	5	25
Aplysia dactylomela	0	0	0	0	0	1	3	10
Septifer forskali	0	0	0	0	4	84	113	113
Diadema setosum	0	0	0	0	1	0	0	0
Vanderhorstia mertensi	0	0	0	0	0	0	1	24

In the past decade we have witness the rapid expansion of some thermophilic alien species along the coast of Turkey. It would be of interest to management to learn whether this could be ascribed to qualities inherent to these particular species, or to changes in the receiving environment.

References

1 - Goren M, Yokes MB, Galil BS, Diamant A (2008) Indo-Pacific cardinal fishes in the Mediterranean Sea - new records of *Apogon smithi* from Turkey and *A. queketti* from Israel. JMBA2-Biodiversity Records, published online, http://www.mba.ac.uk/jmba/pdf/6417.pdf

2 - Yokes MB, Galil BS (2006) New Records of Alien Decapods (Crustacea) from the Mediterranean Coast of Turkey, with a Description of a New Palaemonid Species. Zoosystema, 28(3): 747-755.

3 - Yokes MB, Galil BS (2006) The first record of the needle-spined urchin *Diadema setosum* (Leske, 1778) (Echinodermata: Echinoidea: Diadematidae) from the Mediterranean Sea. Aquatic Invasions, 1(3): 188-190.

4 - Yokes MB, Galil BS (2006) Touchdown - first record of *Percnon gibbesi* (H. Milne Edwards, 1853) (Crustacea: Decapoda: Grapsidae) from the Levantine coast. Aquatic Invasions, 1(3): 130-132.

5 - Meriç E, Yokes MB, Avsar N (2008) *Amphisorus hemprichii* Ehrenberg (Rhizopoda, foraminifera) along the Antalya coast. *Micropaleontology*, 54 (3-4): 277-292.

6 - Yokes MB, Bilecenoglu M, Goren M, Galil BS and Diamant A. 2009. Genetic evidence for wide distribution of the alien prawn-goby, *Vanderhorstia mertensi* Klausewitz, 1974 (Gobiidae) along the northeast Mediterranean. *Acta Ichthyologica et Piscatoria*, 39 (2) (in press).

PRIMARY PRODUCTION IN SHELF WATERS OF THE CILICIAN BASIN

N. Yücel [1]*, E. Erdogan [2], Z. Uysal [1], S. Tugrul [1] and E. Özsoy [1]
[1] Institute of Marine Science, Middle East Technical University - nebil@ims.metu.edu.tr
[2] Mersin University

Abstract

Primary production and phytoplankton composition have been studied seasonally between September 2008-April 2009 at two shelf stations in the Cilician basin of NE Mediterranean. Depth integrated primary production rates varied between 0.048 and 1.6 mgC.m^{-3}h^{-1} at the two shelf stations (30 and 200 m deep). Picoplankton (0.2-2.0 mm) dominated primary production in winter, replaced by larges sized cells (>5 mm) in spring. Total chlorophyll-a concentrations decreased from a high level of 0.93 µg/L in the nearshore to a low level of 0.02 µg/L in offshore waters throughout the sampling period. Primary production data were consistent with total chlorophyll-a and particulate organic carbon measurements.

Keywords: Primary Production, Chlorophyll-a, Coastal Waters, Eastern Mediterranean

Introduction

The eastern Mediterranean waters are known to be ultra-oligotrophic [1], with PO_4 < 0.02 mM and NO_3 < 0.3 mM in the upper mixed layer in summer-autumn, chlorophyll-a being below 0.05 mg/L in the deep basin. The daily rates of primary production varied from 38.5 to 250 mgC m^{-2} d^{-1} in the Cilician basin in 1991 and 1992 [2]. Recent daily rates calculated for the offshore and near shore waters varied in the range 6.0±3.1 and 180±176 mgC m^{-3} d^{-1} [3]. Typical phytoplankton blooms were observed during early spring (February - March), exhibiting a pronounced subsurface maximum below the thermocline during summer [2].

Material and Methods

Two shelf stations (the shallow one: 30 m deep; the other 200m), located in the Mersin Bay of the Cilician basin (Fig. 1) were visited in September 2008, February and April 2009. To measure total and size fractioned primary production, ^{14}C added seawater samples were incubated *in situ* during midday for about 2-3 hours. Chlorophyll-a was measured by the conventional fluorometric method; particulate organic matter (POM) by a CHN analyzer, nutrients by a multichannel auto-analyzer, ^{14}C counts by Perkin Elmer Tricarb 2810 TR scintillation counter.

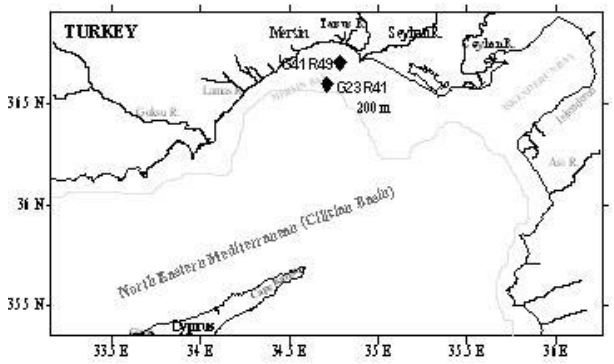


Fig. 1. Sampling stations visited in the Cilician basin

Results

In the Cilician basin, Primary Production (PP) rate was as low as 0.048 mgC.m^{-3}h^{-1} in offshore, increasing to 1.6 mgC.m^{-3}h^{-1} in near shore waters of Mersin Bay fed by river and domestic discharges. In the nutrient-depleted Cilician basin, PP was dominated by picoplankton (0.2-2.0 mm) in February and by larger cells (>5 mm) in April 2009. A highly significant correlation exists (P = 0.01 n = 48 r = 0.604) between total chlorophyll and PP rates. Total chlorophyll concentrations increased from a low level of 0.02 µg/L in the offshore to 0.9 µg/L levels in nearshore waters of the Mersin bay (Cilician basin) throughout the sampling period. POM data have also displayed similar spatial variations whereas the nitrate and phosphate were almost consumed in the upper layer due to limited inputs from external and internal sources.

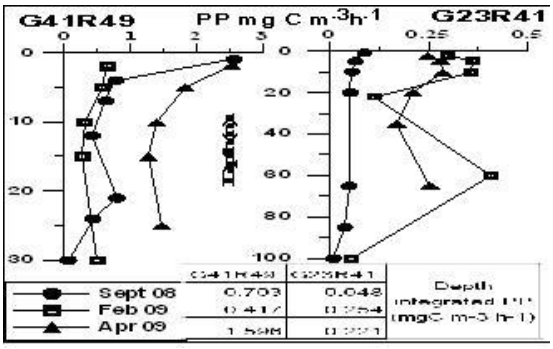


Fig. 2. Total PP rates (mgCm^{-3}h^{-1}) measured in the Cilician basin in 2008-2009

Acknowledgements: This study was supported by the Scientific and Technological Research Council of Turkey (TÜBITAK-SINHA107G066 project).

References

1 - Yilmaz, A., Ediger, D., Bastürk, Ö., Tugrul, S., 1994: Phytoplankton fluorescence and deep chlorophyll maxima in the northeastern Mediterranean. *Oceanologica Acta*, 17(1): 69-77.

2 - Ediger, D., 1995. Interrelations among Primary Production, Chlorophyll and Environmental Conditions in the Northern Levantine Basin, PhD Thesis, METU, Institute of Marine Sciences. Erdemli/Mersin. S187.

3 - Yilmaz, D., 2006. Temporal variation of phytoplankton in the northeastern shelf of Mediterranean Sea: Composition, pigment signature and production. Ph.D. Thesis, Institute of Marine Science, Middle East Technical University, Mersin, Turkey, 165 pp.

DISTRIBUTION OF *MERLUCCIUS MERLUCCIUS* (LINNAEUS, 1758) AND *MERLANGIUS MERLANGUS* (LINNAEUS, 1758) IN THE SEA OF MARMARA (1992-1995)

Ahsen Yuksek [1], Erdogan Okus [1], Ayhan Uysal [1] and Nazli Demirel [1]*
[1] Institute of Marine Sciences and Management, Istanbul University - yanenade@hotmail.com

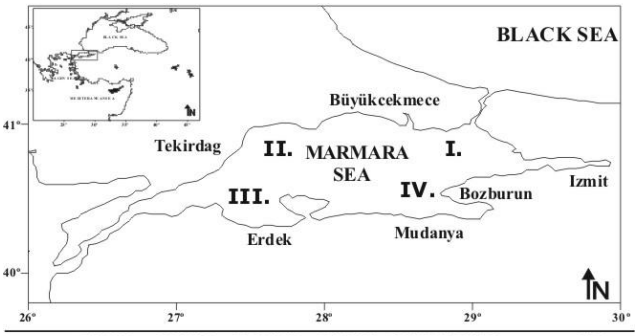
Abstract
Present study has been carried out in 34 trawling stations in the Sea of Marmara between 1992-1995, fish stocks and distribution has been investigated using trawling gear and the effect of physico-chemical conditions monitored. The fishes have been separated from trawl material and distributions, stock size and conditions have been investigated. Hake biomass was highest whole year and its percentage in total economical demersal fish stocks was around 50-60 % annually. Cod biomass was following the hake, especially its stock size has been gradually increased by years and its percentage was around 15-20 %.
Keywords: Demersal, Fishes, Stock Assessment

Introduction
The Sea of Marmara is the second fishing ground after Black Sea with respect to fishing in Turkey. The annual average fishing has been 87.04 % in the Black Sea, 7.58 % in the Sea of Marmara, 3.57 % in the Aegean Sea, and 1.50 % in the Mediterranean Sea [1]. The general problems of the Sea of Marmara are the intense population and industrial areas on the shores, resulting organic and inorganic pollution and the interaction of the eco-systems of two different seas. This type of pollution is an important reason for the narrowing of species distribution areas. The rapidly growing industry, the related increase in population, the distribution of port services and all discharges from the land into bays and gulfs, which are the most productive regions of sea eco-systems, are leading to an increase in pollution. Therefore, degradation can be observed in very important egg-laying areas. The situation experienced in the gulfs of Izmit, Gemlik and Bandirma is one of the best examples. In this way, new stock areas disappear every day, because of insufficient precautions, and stocks and fishing are affected negatively as a result. Detailed studies on biomasses and stocks, based on numeric data remain insufficient in regards to the sea life of the Sea of Marmara that is significantly important on fishing activities.

Materials and Method
Sampling studies have been made at a total of 32 stations in the summer and winter seasons between 1992-1995, taking into account the depth scale ratios of the Sea of Marmara. During the research, demersal fish distribution was observed in different ecological regions in the Sea of Marmara. Therefore, 4 sub-regions were specified and the stock values were calculated.
Region I comprises the Southeast part of the Sea of Marmara. The line drawn between the south exit of the Bosphorus and approximately Bozburun constitutes the border of this region. Since this region comprises gulfs and shores with heavy industrial activities, the water here is affected by industrial waste and this region constitutes the most polluted and unproductive region of the Sea of Marmara (20-110 m = 289.3 km^2).
Region II comprises mainly the northern part of the Sea of Marmara. It stretches from the south exit of the Bosphorus to Mürefte. This region is not appropriate for trawl fishing and its eastern part is subject to limitations stemming from the nature of the ground, the vessel circulation and industrial waste (20-110 m = 1056.0 km^2).
Region III comprises mainly the southern part of the Sea of Marmara. This region contains very appropriate places for trawl fishing (20-110 m = 1863.0 km^2).
Region IV comprises the Southwest part of the Sea of Marmara. Although the region's surface is relatively small, it is the most productive part of the Sea of Marmara according to 1993 data (20-110 m = 1538.8 km^2).

Results and Discussion
The hake alone represents 56 % of the total catch between 1992-1994. Decreasing to catch trend to 33% in the winter of 1994 was determined while it was 81 % in the summer of 1993. In the winter of 1995, sudden increase of all fish stocks were determined again. Consequently, the proportion of the hake to the total catch increased to 48 % parallel to the increase in all other fish stocks.
Generally, hake could be seen in between Büyükçekmece and Marmara Ereglisi in the northern, Erdek Gulf and the entrance of the Dardanelles in southwestern and the northwest of Imrali Island in southern Sea of Marmara.
Distribution of cod was slightly difficult to observe in the northern part. However in the summer of 1992, it has been observed a slight availability in Marmara Ereglisi. In 1995, species distribution observed in a change of its location to the east for cod stocks and in the same period main distrbituion area was recorded at the entrance of Izmit Gulf. The actual distribution area of this species is southeastern and southern Sea of Marmara where the Mediterranean current is very effective at the bottom (Dardanelles and Bay of Erdek).

Evaluation of the bimass ratio of hake and cod amongst other species, opposition of bimass values and distributinal aspects was recorded between those two species that shares nearly the same habitat. While hake biomass in total fishing amount decreased, cod biomass was detrmined in increasing trend and vice versa. Similar feeding strategies is evaluated for the most important reason of this situation. Both hake and cod are known as predators. It has been considered as an important result that distributional effects and food availabilty between those two species and its relation in fisheries.



PERIOD	REGION I (t)		REGION II (t)		REGION III (t)		REGION VI (t)		SEA OF MARMARA (t)		SE %		Fishing comp.%	
	Hake	Cod	Hake	Cod	Hake	Cod	Hake	Cod	Hake	Cod	Hake	Cod	Hake	Cod
1992-W	30,2	-	237,9	-	324,4	17,5	964,6	102,0	1471,5	150,2	7	21	56	6
1992-S	9,1	-	121,0	29,4	655,5	359,1	781,2	207,9	1585,2	615,3	6	10	49	19
1993-W	41,1	0,3	421,2	-	545,1	401,0	1155,2	143,7	2281,4	489,9	5	12	61	13
1993-S	21,8	-	295,9	-	134,0	195,9	440,1	263,1	1021,7	514,0	8	11	50	25
1994-W	7,0	3,1	60,1	-	399,0	812,0	234,2	275,7	799,8	1059,5	9	8	33	43
1994-S	7,8	-	83,6	-	82,1	75,2	279,1	206,8	454,4	314,4	12	14	42	29
1995-W	28,9	12,3	137,9	25,2	253,0	147,8	204,5	58,7	637,9	254,5	10	16	48	19

Fig. 1. Study area and the changes of biomass values of hake and cod in years with region

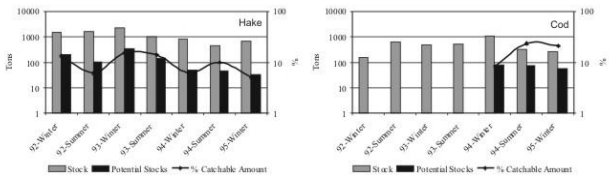


Fig. 2. Stock values of hake and cod in years in the Sea of Marmara

References
1 - Uslu O., Benli A.H., 1998. Deniz Kaynaklarinin Yönetimi ve Kirlilik Kontrolü. Devlet Planlama Teskilati Ulusal Cevre Eylem Plani, Ankara.

STUDIES ON THE BIOLOGY OF THE VULNERABLE FISH *APHANIUS FASCIATUS* NARDO 1827 (CYPRINODONTIDAE) AT THE GHADIRA WETLAND IN THE MALTESE ISLANDS

Marion Zammit-mangion [1]*, Charles Gauci [2] and Mark Gauci [2]
[1] University of Malta, - mzam1@um.edu.mt
[2] Birdlife Malta

Abstract
A population of *Aphanius fasciatus* Nardo 1827 from a wetland community in the Maltese islands was sampled for four months. The sex and juveniles ratios, reproductive state and lengths were studied. The population showed an abundance of females (3:1), a relatively high investment in juveniles and sustained reproduction typical of fish species that inhabit harsh environments. In this study females were found to be slightly shorter than males.
Keywords: Fishes, Growth, Lagoons

Introduction
Over the last decade and largely in response to human pressure *A. fasciatus* Nardo 1827 has disappeared rapidly from the Maltese Islands, so that it is now properly recorded at just two geographically isolated sites occupying a total of 0.15km^2(1). Despite the fact that locally it is classified as vulnerable there are few scientific studies on the biology of this organism. This paper provides information on *A. fasciatus* from one of the above sites, the Ghadira wetland in Mellieha. The site consists of land nestled between two hills and just inland of the sea at Mellieha bay. The wetland consists of a central saline pool that rapidly becomes hypersaline during the peak summer months. To the west of the pool lies a freshwater reservoir which is considerably deeper than the central pool. A total of 841 fish were sampled four times between June and October 2008 using baited minnow traps in the saline waters of the central pool and in the freshwater reservoir (over 2.5m in depth). A shallow channel maintains connection between the two in the summer months. Abiotic factors were monitored throughout this period. Identification of the adult fish was facilitated by the sexual dimorphism exhibited by males and females of the genus *Aphanius*. Juveniles were identified as being 27mm or under in size.

Results and Discussion
At the wetland the females were more abundant and overall a sex ratio of 3:1 was recorded. The higher ratio of females is typical of fish species that inhabit harsh environments where greater investment in reproductive capacity is necessary. Similar ratios were oberved in other studies on killifish in lagoon habitats which indicates that the Greek and Maltese habitats are exposed to similar abiotic features such as hypersalinity and high temperatures (2). Females exhibited sustained reproductive behaviour with swollen bellies typical of pregnant fish from April through to late October while temperatures remained warm and favourable. The ratio of juveniles to adults was 1:1.3 or approximately 50% of the total population which is again indicative of high investment in the generation of juveniles. Females were slightly shorter (54.4mm SD8.6mm) than males (57.6mm SD 8.9mm). The mean size of the killifish reported at the Ghadira wetland is larger than that reported in other studies on similar habitats (2) and a contributing factor is the freshwater reservoir where the mean size of fish is considerably larger (60.5mm) than in the central saline pool (42.4mm). While the population in the central pool remains vulnerable as they are exposed to extreme abiotic conditions, the freshwater reservoir offers a reserve for the adult killifish where conditions are more favourable. The conservation of this part of the reserve is therefore critical to the survival of the population.

References
1 - Deidun A., Diacono I., Tigano C. and Schembri P.J., 2002. Present distribution of the threatened killifish Aphanius fasciatus (Actinopterygii, Cyprinodontidae) in the Maltese islands. *Central Mediterranean Naturalist.* 3 (4) 177-180.
2 - Leonardos I. and Sinis A., 1999. Population age and sex structure of Aphanius fasciatus Nardo, 1827 (Pisces Cyprinodontidae) in the Mesolongi and Etolokon lagoons (W. Greece). *Fisheries Research*, 40, 3, 227-235.

EVALUATION DU STOCK DE PALOURDES (*RUDITAPES DECUSSATUS*) DES ZONES DE PRODUCTION DE SFAX (GOLFE DE GABES, TUNISIE)

N. Zamouri Langar [1]*, M. Ghorbel [1], S. Fifas [2], O. Jarboui [1] and R. Mrabet [1]
[1] Institut National des Sciences et Technologie de la Mer, 2025 Salammbô, Tunisie - nedra.zamouri@instm.rnrt.tn
[2] Ifremer, centre de Brest, 29280 Plouzané, France

Abstract
La palourde *Ruditapes decussatus* (bivalve, Veneridae) est la seule espèce de coquillage officiellement exploitée en milieu naturel sur les côtes tunisiennes. Néanmoins, en l'absence d'informations concernant son stock nous avons mené cette étude. L'exploitation de la palourde dans le gouvernorat de Sfax est réalisée dans des zones de production dont la délimitation est effectuée par l'administration (Direction Générale de la Santé Animale). Des campagnes de prospection, durant l'année 2004, ont permis l'échantillonnage de palourdes et nous avons calculé l'abondance et les biomasses dans chacune des six zones de production de la côte régionale de Sfax.
Keywords: Bivalves, Biomass, Population Dynamics

Résultats et Discussion

Le volume du sédiment prélevé par échantillon correspond à une surface d'un quadra de 0,25 m^2 et une hauteur de sédiment de 30 cm. Deux quadras simultanés sont effectués par station. Les échantillons au nombre de 552, réalisés dans 271 stations situées sur 47 radiales le long de la côte de Sfax (Figure 1), ont été tamisés sur place sur un maillage de 2 mm de côté. Ayant recours à la méthodologie utilisée dans l'évaluation du stock des palourdes du bassin d'Arcachon [1] et des populations de bivalves dans le golfe Normand-breton [2], nous avons calculé l'abondance, en nombre d'individus et les biomasses en Kg ainsi que leurs écarts types associés (Tableau 1), de la population de *R. decussatus* dans chaque zone de production (de S1 à S6) tout en respectant la délimitation administrative.

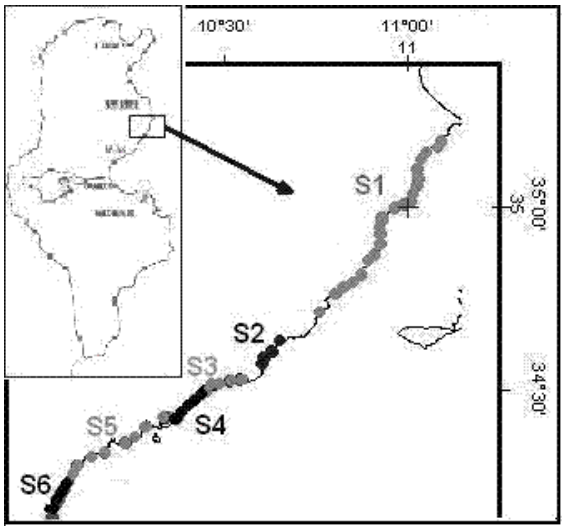


Fig. 1. Distribution des zones de production de la palourde dans la région de Sfax

L'abondance relative de *R. decussatus* dans la région de Sfax varie d'environ 3,2 à 121 millions d'individus, avec des écarts types respectifs de 1,4 $x10^6$ à 56,2 $x10^6$ (Tableau 1). Les zones de production situées au nord de Sfax présentent les plus faibles valeurs et sont moins riches en palourdes. En effet, dans les deux zones S1 et S2, respectivement 13,5 % et 9,6 % des stations uniquement comprenaient des palourdes. Par contre, les zones S5 et S6, situées au sud de la région de Sfax, sont les plus densément peuplées avec respectivement 43 et 121 millions d'individus. Malgré une abondance moindre, la région S3 détient une valeur de biomasse supérieure à celle en S1. Les palourdes rencontrées dans les prélèvements en S3 sont plus âgées qu'en S1, elles ont des tailles plus grandes.

Tab. 1. Abondances(T_i), biomasses (B_i) et écarts types (ET) de la palourde dans la région de Sfax

Zone	B_i/m^2 (g/m²)	T_i $\times10^7$ (ind)	ET (T) $\times10^7$	B_i $\times10^4$ (Kg)	ET (B_i) $\times10^4$
S1	1,9	2,4	1,2	7,2	3,8
S2	3,1	0,3	0,1	0,9	0,4
S3	28,2	1,6	0,3	9,4	2,8
S4	11,7	1,3	0,3	4,1	0,8
S5	17,7	4,3	2,1	14,1	6,6
S6	132,1	12,1	5,6	33,3	12,9
total	11,9	22,1		69,1	

Les résultats de l'étude de l'abondance et des biomasses moyennes par m^2 rejoignent ceux mentionnés ci-dessus, soit S6 la strate la plus peuplée et S1 la strate la plus pauvre en individus de la région ayant respectivement des densités moyennes de 48 et 0,648 individus/m^2 et des biomasses de 132 et 1,921 g/m^2. Hormis la zone de production S6 (132 g/m^2), comparées à d'autres régions dans le monde, on peut considérer que les valeurs trouvées pour la biomasse et l'abondance sont relativement faibles par rapport à celles obtenues dans le bassin d'Arcachon en France (128 g/m^2) [1], (0,4 individu/ m^2, 2g/ m^2) [2] et en Algérie dans le lac El Mellah (atteignant 528 individus/m^2) [3]. Ces mêmes auteurs remarquent également une variation importante selon les strates observées. Cette répartition est à mettre en relation avec le type de substrat et les conditions environnementales [4]. En conclusion, l'évaluation menée durant la période d'étude n'est que relative et il convient de tenir compte de la variabilité interannuelle de la distribution spatiale des gisements pour définir les modalités d'exploitation.

References

1 - Bertignac M., Auby I., Foucard J., Martin S., De Montaudouin X. & Sauriau P. G., 2001. Évaluation du stock de palourdes du Bassin d'Arcachon. IFREMER DRV/RH/RST/2001-05 : 35 pages.
2 - Caill-Milly N., Duclerq B. & Morandeau G., 2006. Campagne d'évaluation du stock des palourdes du bassin d'Arcachon (campagne 2006). IFREMER : 51 p.
3 - Draredja B. et Beldi H., 2004. Distribution de la palourde *Venerupis decussata* (Linnaeus, 1758) dans la lagune Mellah durant la période automne, hiver et printemps. *Bull. Inst. Natn. Sci. Techn. Mer. n° Spécial* (9) : 39-42.
4 - Haouas Gharsallah I., Zamouri N., Jarboui O., Mrabet R. & Missaoui H., 2008. Evaluation et cartographie de coquillages comestibles dans la lagune de Bizerte (Nord de la Tunisie). *Novapex* 9 (1) : 33-40.

CONTRIBUTION A LA CARACTERISATION DE LA MACROFLORE BENTHIQUE DES REGIONS DE BIZERTE, CAP-ZEBIB ET RAF-RAF (TUNISIE, MEDITERRANEE)

Amel Zerzeri [1]*, Aslam Sami Djellouli [1], Yosr Mezgui [1] and Oum Kalthoum Ben Hassine [1]
[1] Unité de Recherche de Biologie, Ecologie et Parasitologie des Organismes Aquatiques, Faculté des Sciences de Tunis, 1002, Tunisie - amel-zerzeri@hotmail.com

Abstract
Un total de 80 espèces ont été identifiées : 47 *Rhodophyta* (59%), 16 *Ochrophyta* (20%), 15 *Chlorophyta* (19%) et 2 *Magnoliophyta* (2%). Six pourcents du nombre total des espèces inventoriées sont des espèces exotiques d'origine Indo-pacifique dont une est signalée pour la première fois en Tunisie (*Acrothamnion preissii*) et 28 espèces sont nouvelles dans la région d'étude.
Keywords: Algae, Alien species, Biogeography

Le littoral tunisien est largement ouvert à des influences variées de part sa position charnière entre les deux bassins, occidental et oriental de la Méditerranée et la morphologie de ses côtes. Cela laisse supposer la présence d'une macroflore benthique où se côtoient des groupes biogéographiques très différents. Cependant, les travaux sur la macroflore benthique de la Tunisie sont rares, ponctuels et fragmentaires dans le temps mais aussi dans l'espace [1]. Dans l'objectif de connaître la grande diversité de la macroflore benthique des côtes tunisiennes, nous avons entrepris l'étude des caractéristiques systématiques et écologiques du macrophytobenthos de la frange littorale nord-est de la Tunisie, localisée au nord du golfe de Tunis. L'étude porte sur un ensemble de trois sites, répartis le long du littoral Nord et Nord-est des côtes tunisiennes : Bizerte, Cap-Zebib et Raf-Raf, situés entre les parallèles 37°17'17'' et 37°16'57'' Nord et les méridiens 10°13'57.9'' et 10°14'10.5'' Est. Les prospections ont été réalisées selon un plan d'échantillonnage mensuel, durant une période s'étalant de juillet 2005 à juillet 2006 (inclus) et à une profondeur variant de zéro à dix mètres. L'analyse de l'ensemble des prélèvements nous a permis d'identifier au total 80 espèces comprenant 47 *Rhodophyta*, 16 *Ochrophyta*, 15 *Chlorophyta* et 2 *Magnoliophyta*.

Chlorophyta : *Acetabularia acetabulum*, *Bryopsis duplex*, *Caulerpa racemosa* var. *turbinata-uvifera*, *Caulerpa racemosa* var. *cylindracea*, *Cladophora prolifera*, *Cladophora hutchinsiae*, *Codium bursa*, *Codium fragile*, *Codium vermilara*, *Dasycladus vermicularis*, *Enteromorpha linza*, *Flabella petiolata*, *Halimeda tuna*, *Ulva rigida*,*Valonia utricularis*.

Ochrophyta : *Cladostephus hirsutus*, *Colpomenia sinuosa*, *Cystoseira mediterranea*, *Cystoseira compressa*, *Dictyopteris membranacea*, *Dictyota dichotoma* var. *dichotoma*, *Dictyota dichotoma* var. *intricata*, *Dictyota linearis*, *Ectocarpus siliculosus* var. *siliculosus*, *Ectocarpus fasciculatus*, *Padina pavonica*, *Sargassum vulgare*, *Scytosiphon lomentaria*, *Sphacelaria rigidula*, *Stypocaulon scoparium*, *Taonia atomaria*.

Rhodophyta : *Acrothamnion preissii*, *Asparagopsis armata*, *Aglaothamnion caudatum*, *Aglaothamnion tripinnatum*, *Amphiroa rigida*, *Antithamnion heterocladum*, *Callithamnion corymbosum*, *Callithamnion tetragonum*, *Ceramium bertholdii*, *Ceramium ciliatum*, *Centroceras clavulatum*, *Ceramium diaphanum* var. *diaphanum*, *Ceramium gracillimum*, *Ceramium flaccidum*, *Ceramium secundatum*, *Champia parvula*, *Chondria coeruslescens*, *Compsothamnion thuyoides*, *Corallina elongata*, *Crouania attenuata*, *Dasya hutchinsiae*, *Erythrotrichia bertholdii*, *Erythrotrichia carnea*, *Erythrocladia subintegra*, *Fosliella farinosa*, *Goniotrichumm alsidii*, *Griffithsia opuntioides*, *Herposiphonia secunda* f. *secunda*, *Heterosiphonia crispella*, *Hypnea cervicornis*, *Hypnea musciformis*, *Hypoglossum hypoglossoides*, *Jania rubens*, *Laurencia obtusa*, *Laurencia papillosa*, *Lithophyllum incrustans*, *Mesophyllum lichenoides*, *Nitophyllum punctatum*, *Peyssonnelia dubyi*, *Peyssonnelia squamaria*, *Phyllophora crispa*, *Pleonosporium borreri*, *Polysyphonia sertularioides* *Polysiphonia opaca*, *Pterocladia capillacea*, *Rytiphlaea tinctoria*, *Sphaerococcus coronopifolius*. *Magnoliophyta* : *Cymodocea nodosa*, *Posidonia oceanica*.

Sur l'ensemble des espèces inventoriées, les *Rhodophyta* constituent le groupe le mieux représenté avec 59% de l'ensemble des espèces recensées, les *Ochrophyta* et les *Chlorophyta* occupent la seconde position avec respectivement 20% et 19% du nombre total des espèces. Par ailleurs, le rapport R/P (Rhodophyceae/Phaeophyceae) [2], calculé pour l'ensemble des sites étudiés est de 2.9 et reflète un caractère d'affinité tempérée, correspondant au bassin occidental. De plus, le regroupement des espèces inventoriées en fonction de leurs affinités biogéographiques [3-4], nous a permis de constater que l'élément Atlantique est dominant avec 45%, suivi de l'élément Cosmopolite avec 34% puis de l'élément Méditerranéen avec 11%. Les espèces à affinité tropicale représentent, quant à elles, 10% et sont formées par 6% pour l'élément indo-pacifique et 4% pour l'élément pantropical. La macroflore benthique de la région étudiée est donc un mélange hétérogène, constitué par plusieurs espèces d'affinités diverses. Parmi les espèces inventoriées, cinq d'entre elles retiennent notre attention, en raison de leurs caractères exotiques et leur origine Indo-pacifique [4], soit: (1) *Caulerpa racemosa* var. *turbinata-uvifera*, (2) *Caulerpa racemosa* var. *cylindracea*, (3) *Asparagopsis* sp, (4) *Codium fragile* et (5) *Acrothamnion preissii*. Ces espèces exotiques représentent tout de même 6 % du nombre total des espèces inventoriées. En outre, dans cette étude, nous signalons pour la première fois *Acrothamnion preissii* sur les côtes tunisiennes. En conclusion, le nombre d'espèces inventoriées dans ce travail (80 espèces) représente 19.32% de la flore marine connue à ce jour sur le littoral tunisien et reporté par Ben Maïz [1]. 28 de ces espèces sont mentionnées pour la première fois dans le secteur d'étude et dont une est nouvelle pour la Tunisie.

References
1 - BEN MAIZ N., BOUDOURESQUE C.F., OUAHCHI F., 1987.Inventaire des algues et phanérogames marines benthiques de la Tunisie. *Giorn.Bot.Ital*.,121 (5-6) :259-304.

2 - FELDMAN J., 1937.Algues marines de la côte des Albères. I-III : Cyanophycées, Chlorophycées, Phéophycées. *Rev. algol*., Fr., 9 (3-4) : 141-329, + pl. 1-10.

3 - CORMACI M., DURO A., FURNARI G., 1982 - Considerazioni sugli elementi fitogeografici della flora algale della Sicilia. *Naturalista sicil.* S. IV, 6 (Suppl.):7 - 1 4.

4 - VERLAQUE M., RUITTON S., MINEUR F., BOUDOURESQUE C.F., 2007. CIESM Atlas of exotic macrophytes in the Mediterranean Sea. *Rapp. Comm. int. Mer Médit.*, 38.

A COMPARISON OF THE PRECISION OF RED MULLET (*MULLIDAE*) AGE DETERMINATION BY THE USE OF DIFFERENT BONY STRUCTURES AT THE STRAIT OF GIBRALTAR REGION

Abdelaziz Zoubi [1]*, Abdeljaouad Lamrini [2], Abdellatif Berraho [1] and Allal Hamouda [2]
[1] Institut National de Recherche Halieutique - abdelaziz_zoubi@hotmail.com
[2] Institut Agronomique et Vétérinaire Hassan II

Abstract
The goal of this study was to determine the most reliable bony structures (scales, whole and broken otoliths) for ageing the striped red mullet at the strait of Gibraltar region. The results showed for all structures a high percentage of agreement between the young individuals age readings carried out by observations of whole and broken otoliths; the age determined for old individuals by scales and whole otoliths seemed underestimated.
Keywords: Strait Of Gibraltar, Fisheries, Population Dynamics, Growth

Introduction
The striped red mullet (*Mullus surmuletus* Linnaeus, 1758), is one of the most commercially important fish species targeted by trawl fishery at the Moroccan waters. The area of study extends from the Strait of Gibraltar to Larache region. The accumulating evidence that scales can provide unreliable estimates of age has forced fishery scientists to use other calcified structures, especially otoliths [1]. Thus, the specific objectives of this study were to determine the precision of age estimated for this species using different hard structures.

Materials and methods
The samples of data used in this study were collected in 2005 by commercial category (small, medium and big), using a stratified random sampling of monthly commercial landings of trawlers made at the fish auction of Larache.
Samples of 114 individuals, ranging in size between 12 to 28 cm, were measured by their fork length to the nearest centimetre. In the laboratory; fish scales and sagittal otoliths by length class of 1 cm were removed from each fish and were washed and stored dry [2]; for age determination, Scales, whole and broken otoliths through the focus were illuminated with reflected light and were examined under a dissecting microscope with a dark background [3] .
The readings were done without knowledge of scales or otoliths reference (length). All samples of scales and otoliths were interpreted separately three times. If all the three readings are different, the material is rejected. Only complete hyaline zones were counted using Guidelines for pattern interpretation generally based upon standardized interpretation presented in the CARE Age Reading Manual [4].
Several measures were used to determine the precision (reproducibility) of ages assigned using these structures. The Percent of Agreement (the percentage of age readings that agree with the modal age which represents the age for which most readings agree), the standard deviation (sd) and the coefficient of variation (CV =100 x sd/mean) [5], were used. Age readings were analyzed with a spreadsheet developed by Guus Eltink [6].

Results
The results show that the Percent of Agreement (P.A.) decreased for all structures over age 5 and indicate that precision (CV) between readings using whole otoliths remains slightly high as assigned ages increased (Table 1). For the scales, whole and broken otoliths CV's increased with increasing fish age, indicating that readings agreement decreased as fish grew older. However, the age reading agreement for whole otoliths kept high even for older individuals.

Tab. 1. Comparison of readings P.A. and CV among ages assigned using scales, whole and sectioned otoliths for two groups of striped red mullet

Age/ Structure	Sample size	Scales		Whole otoliths		Broken otoliths	
		PA (%)	CV	PA (%)	CV	PA (%)	CV
Fish with age less or equal to 5 years	75	67.04	14.98	82.52	11.86	95.14	5.13
Fish with age greater than 5 years	39	59.17	26.45	68.72	21.15	83.46	10.48

Discussion and Conclusions
The results of the study show that the determination of age by the use of whole otoliths and scales is less precise by comparison to that estimated from broken otoliths. In general, we found that broken otholith yielded the most precise age estimates for red mullet. Whole otoliths was equally useful for ageing the species but only for individuals not old (less or equal to 5 years); over this age, the ages determinations using both scales and whole otoliths are underestimated by comparison with broken otoliths. Studies have consistently shown higher precision in ages assigned with otoliths than with scales in walleyes [7].

References
1 - Hammers, B. E. and Miranda L. E., 1991. Comparison of methods for estimating age, growth, and related population characteristics of white crappies. *North American Journal of Fisheries Management* 11: 492-498.
2 - Holden, M.J. and Raitt D.S.F., 1975. Manual of fisheries science. Part 2. Methods of resources investigation and their application. FAO Fish.Tech.Pap. (115) Rev.1: 214 p.
3 - Belanger, S. E. and Hogler S. R., 1982. Comparison of five ageing methodologies applied to walleye (Stizostedion vitreum) in Burt Lake, Michigan. *Journal of Great Lakes Research* 8 : 666-671.
4 - C.A.R.E., 1997. Manual on Generalized Age Determination Procedures for Ground fish. 63 p.
5 - Chang, W. Y. B., 1982. A statistical method for evaluating the reproducibility of age determination. *Can. J. Fish. Aquat.* Sci. 39, 1208-1210.
6 - Eltink, A.T.G.W., Newton, A.W., Morgado, C., Santamaria, M.T.G. and Modin, J., 2000. Guidelines and tools for age reading comparisons–version 1 October 2000. EFAN Report 3-2000, 75 p.
7 - Isermann, D. A., Meerbeek J. R., Scholten G. D. and Willis D. W., 2003. Evaluation of three different structures used for walleye age estimation with emphasis on removal and processing times. *North American Journal of Fisheries Management* 23 : 625-631.

THE GEAR SELECTIVITY EFFECT ON GROWTH PARAMETERS OF AXILLARY SEABREAM, *PAGELLUS ACARNE (SPARIDAE)* AT THE MOROCCAN WESTERN MEDITERRANEAN

Abdelaziz Zoubi [1]*, Abdeljaouad Lamrini [2], Allal Hamouda [2] and Yassine Zahri [1]
[1] Institut National de Recherche Halieutique - abdelaziz_zoubi@hotmail.com
[2] Institut Agronomique et Vétérinaire Hassan II

Abstract
We examined the effects of gear selectivity on the estimation of growth parameters of Axillary seabeam from western Mediterranean. For longline and trawl nets, there were differences between the von Bertalanffy growth estimates derived from the two fishery's mean values of length-at-age. For longline fishery, a selectivity-related bias in the estimation of growth parameters was recorded, yielding unrealistic estimates of t_0.
Keywords: Fisheries, Fishes, Growth, Western Mediterranean

Introduction
The axillary seabeam, *Pagellus acarne* (L.) (Sparidae), is widely distributed along the continental shelf at the Atlantic and Mediterranean waters [1]. Abundant in Moroccan Mediterranean waters, this species is commercially exploited at depths between 80 and 150 meters by longliners (up to 20 % of landings in weights) using gill nets and hooks and also with trawlers by means of deep trawl net (about 80 % of landings in weights) [2].

Materials and methods
The area of study covered the sparidae fisheries located at the Strait of Gibraltar region of Morocco which extends from M'diq to Larache. The samples of data were collected in 2004 and 2005 at the fish auction of Larache by using a stratified random sampling of Axillary seabream monthly landings of trawlers and longliners .
Samples of 510 individuals, ranging in size between 10 to 28 cm fork length were measured to the nearest centimeter; for age determination, 5 scales by length class of 1 cm, were removed, washed, viewed with a magnification of 50x; fish were considered to be 1 year old after the formation of the first winter ring. Fish age was determined by two different readers with no knowledge of fish length or month and gear of capture. If the two readings agreed, then the age was adopted as definitive. If the two readings differed, the scale was omitted from further analysis.

The Von Bertalanffy theoretical growth parameters and the corresponding variances were estimated separately for trawl and longline fisheries by using FISHPARM program [3]. To test for the selectivity effect on the estimation of growth parameters, we undertook a comparison of the growth parameters derived separately from data of trawl and longline fisheries and the corresponding variances. The Hotlling's T^2 test [4], was also used to compare the parameters of both fisheries.

The three theoretical Von Bertalanffy growth parameters and the corresponding variances were estimated separately by type of fishery (Table 1).

Tab. 1. The Von Bertalanffy growth parameters (L_∞, K, t_O) with the corresponding variances estimated by type of fishery

Year	Sample size	Length interval	Age interval	L_∞		K		t_0	
				value	variance	value	variance	value	variance
Trawl fishery									
2004	780	10 – 28 (cm)	0 – 8 (year)	34,82	1,42	0,152	0,00172	-1,942	0,24
2005	809			33,63	2,10	0,187	0,000557	-1,889	0,0529
Longline fishery									
2004	198	21 – 29 (cm)	4 – 8 (year)	32,58	7,55	0,146	0,00276	-4,071	2,66
2005	205			32,74	13,8	0,137	0,00359	-4,495	3,40

Results and Discussion
Results showed that trawlers caught fish with ages ranging between 0+ and 8 years; in contrast, longliners were targeting only bigger fish of age 4 to 8 years. Moreover, we found significant differences for all three growth parameters obtained by type of fishery (Hotlling's T^2 test, $P < 0.001$). The examination of the parameters of growth obtained in table 1, shows a t_0 strongly negative; by comparison to trawl fishery, the variances associated with the estimated parameters of growth for longline fishery are rather high. Therefore, it appeared that the t_0 parameter is very sensitive to the first age groups. In fact, gear selectivity can influence estimates of growth parameters [5]. It is difficult to obtain samples representative of the population's age structure when using a single gear because of the size selectivity of most gears [6]. To allow for obtaining more reliable estimates of growth parameters of a stock, the data representing the whole range of fish length should be used [7].

References
1 - Bonnet M., 1969. Les sparidés des côtes nord ouest africaines. *Rev. Trav. Inst. Pêches Marit.*, 33 (1) : 97 – 116.
2 - Lloris D. ; Rucabado, J., 1998. Guide FAO d'identification des espèces pour les besoins de la pêche. Guide d'identification des Ressources Marines Vivantes du Maroc. Rome, FAO. 1998. 263 p.
3 - Saila S. B., Recksiek C.W. and Prager H., 1988. Basic fishery science programs. A compendium of Microcomputer programs for the growth parameters evaluation operation. *El sevier, Dev. Aquacult. Fish. Sci*, 18 : 231 p.
4 - Bernard, D. R., 1981. Multivariate analysis as a mean of comparing growth in fish. *Can. J. Fish. Aquat. Sci*. 38 : 233–236.
5 - Potts J., Manooch III C. S. and Vaughan D. S., 1998. Age and growth of vermilion snapper from the southeastern United States. *Trans. Am. Fish. Soc*. 127: 787–795.
6 - Bagenal, T. B. and Tesch F. W., 1978. Age and growth. *In* Methods for assessment of fish production *in :* fresh waters (T. B. Bagenal, ed.), pp 101–136. Blackwell Scientific Publications, Oxford.
7 - Ricker, W. E., 1969 . Effects of size-selective mortality and sampling bias on estimates of growth, mortality, production and yield. *J. Fish. Res. Board Can*. 26 :479–541.

MITIGATING THE IMPACTS OF COASTAL DEFENCE MEASURES

Laura Airoldi [1]* and Shimrit Perkol-Finkel [1]
[1] University of Bologna - laura.airoldi@unibo.it

Abstract

Defense measures have a strong impact on species composition, abundance and diversity of coastal marine environments. Understanding the factors controlling these impacts is crucial for proper management of coastal areas. We show results of field studies aiming at developing means for promoting the growth of desirable species and for controlling the spread of invasive species on coastal man-made structures

Keywords: Adriatic Sea, Coastal Management, Species Introduction, Biodiversity, Coastal Engineering

Evidence for severe loss of marine habitats is increasing worldwide, stirring concern because of their recognized ecological and economical values (1). Recent estimates suggest that > 60% of native habitats may have been lost throughout history in many coastal areas of the planet (2). Losses have resulted from natural and particularly from anthropogenic factors driving marine systems through thresholds of degradation (3). Losses are ongoing at accelerating rates and overall benefits of current protection measures are low. Urbanization is one of the leading causes for habitat and species loss in coastal waters. Today 22,000 km^2 of European coastlines are covered by urban marine structures and further development is expected (2). Such structures are often built on sandy bottom where they generate changes in species composition, abundance and diversity. Understanding the factors controlling such changes is crucial for proper management of coastal areas. The current research aims at outlining a new approach of sustainable management of urban marine structures, by incorporating ecological knowledge of their functioning and of the appropriate scales, spatial and temporal, of management. We show results of past and ongoing experimental field work which specifically dealt with: 1) analyzing the impact of coastal artificial structures on native assemblages, 2) monitoring the spread of nuisance or invasive species on coastal artificial structures, and 3) developing means for promoting the growth of desirable species. These studies have been done along the 190 km of coastal defence and other armoured urban infrastructures along the Italian North Adriatic Sea. Results show that the proliferation of coastal defense measures causes a disruption of native soft-bottom environments and unnatural changes to the composition, abundance and diversity of native assemblages. Proliferation of coastal defense structures can also have critical impacts on regional species diversity, removing isolating barriers, favoring the spread of non-native species and increasing habitat heterogeneity (4, 5, 6). In order to provide advice about how to mitigating the impact of these measures on the environment, we tested the feasibility of promoting the growth of desirable native species on urban marine structures, using the canopy-forming alga *Cystoseira barbata* as model species. We documented the ongoing loss of this species in native habitats in this region in relation to severe anthropogenic disturbances, and their replacement by opportunistic species of lesser habitats complexity. We estimated natural recovery potential by *in-situ* monitoring of subsequent recruitment, survival and growth patterns of *C. barbata* juveniles, and tested the potential for urban armoured structures to provide additional suitable substrata for this species. Transplantation experiments demonstrated that *Cystoseira* has the potential to grow on urban structures, but its success is influenced by several factors, including wave exposure and herbivorous pressure. Urban marine structures do not function as natural habitats. Advancing our understanding of the impact of urban structures on natural habitats, and increasing our ability to control their assemblages is of prime importance in light of the continuous proliferation of these artificial habitats. Management for these artificial habitats should be specifically adapted, aimed at increasing their ability to sustain various ecological and biological applications, for example, by managing their prevailing assemblages. Finally, we suggest that instead of relying on the construction of new artificial reefs for restoration and enhancement, ecologists, engineers and decision makers should consider maximizing the ecological functioning of existing man-made structures. Acknowledgements Work was supported by: the EU projects MarUrbe (FP7-PEOPLE-2007-2-1-IEF-219818), DELOS (EVK3-CT-2000-00041) and THESEUS (FP7 - ENV2009-1, grant 244104), the MIUR project BIORES (Prin 2007) and the University of Bologna Strategic Project ADRIABIO.



Fig. 1. Google view of coastal defense and otherarmoured urban structures along the Italian coasts of the North Adriatic sea

References

1 - Costanza R., d'Arge R., de Groot R., Farber S., Grasso M., Hannon B., Limburg K., Naeem S., O'Neill R. V., Paruelo J., Raskin R. G., Sutton P., and van den Belt M., 1997. The value of the world's ecosystem services and natural capital. *Nature*387, 253-260.

2 - Airoldi L., and Beck M. W., 2007 Loss, status and trends for coastal marine habitats of Europe. *Oceanogr. Mar. Biol. Ann. Rev.*45, 345-405.

3 - Jackson J.B.C., Kirby M.X., Berger W.H., Bjorndal K.A., Botsford L.W., Bourque B.J., Bradbury R.H., Cooke R., Erlandson J., Estes J.A., Huges T.P., Kidwell S., Lange C.B., Lenhian H.S., Pandolfi J.M., Peterson C.H., Steneck R.S., Tegner M.J. and Warner R.R., 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science*293, 629-638.

4 - Airoldi L., Abbiati M., Beck M.W., Hawkins S.J., Jonsson P.R., Martin D., Moschella P.S., Sundelöf A., Thompson R.C. and Åberg P., 2005. An ecological perspective on the deployment and design of low-crested and other hard coastal defence structures. *Coast. Engineer.*52, 1073-1087.

5 - Bulleri F. and Airoldi L., 2005. Artificial marine structures facilitate the spread of a non-indigenous green alga, *Codium fragile* ssp *tomentosoides*, in the North Adriatic Sea. *J. Appl. Ecol.*42, 1063-1072.

6 - Fauvelot C., Bertozzi F., Costantini F., Airoldi L. and Abbiati M., 2009. Lower genetic diversity of populations of the limpet *Patella caerulea* on urban coastal structures as compared to natural rocky habitats. *Mar. Biol.* 156: 2313–2323.

DETRITAL ENRICHMENT FROM MARINE URBAN STRUCTURES AND ITS FAR-FIELD EFFECTS ON SOFT-BOTTOM ASSEMBLAGES

L. Airoldi [1], G. Fontana [1]*, F. Ferrario [1], G. Franzitta [1], S. Perkol-Finkel [1], A. Magnani [1], S. Bianchelli [2], A. Pusceddu [2], M. A. Colangelo [1] and S. Thrush [3]

[1] Centro Interdipartimentale di Ricerca per le Scienze Ambientali in Ravenna, Università di Bologna, Italy - g.fontana@unibo.it

[2] Dipartimento di Scienze del Mare, Università Politecnica delle Marche, Ancona, Italy

[3] National Institute of Water and Atmospheric Research, Hamilton, New Zealand AND DipTeRis, Università di Genova, Italy

Abstract

Here we report the results of a field experiment designed to identifying and quantifying possible local changes in sedimentary environments and associated assemblages related to the deposition of two common but different types of detritus produced by hard bottom species (green algae and mussels) along the coast of the north Adriatic sea.

Keywords: Adriatic Sea, Detritus, Sediments, Artificial Reefs

Coastal marine landscapes have been profoundly altered by the introduction of a variety of human-made artificial structures, such as seawalls, dykes and breakwaters, ([1], [2]). There is mounting evidence that these structures may profound change the environmental and ecological condition of the coastal ecosystem ([3], [4], [5], [6]). However, the broader ecological consequences of these man-made structures that could extend the foot print of their impact are poorly understood. These artificial structures could have important consequences for the functioning of coastal system through the spatial subsidy of detrital material that is sloughed off the artificial structure and changes productivity, nutrient cycling, detrital pathways in the adjacent soft-sediments. We designed an experiment to identify and quantify possible changes in sedimentary environments and associated assemblages related to the unnatural, considerable amount of detritus produced by hard bottom species associated to the urban structures. The study was carried out along the sedimentary coasts of the North Adriatic Sea (Italy). In this area >190 km of artificial structures, mainly groynes and breakwaters, seawall and jetties, have been built along 300 km of naturally low sedimentary shores causing severe loss and alterations of shallow sedimentary habitats [3]. We first identified and quantified the type, amount and distribution of detritus produced by dominant hard-bottom species on the structures. We then carried out a field experiment to analyse the effects of detritus from different organisms (i.e. *Ulva* spp, vs *Mytilus galloprovincialis*) on surrounding sedimentary environments and associated assemblages. We predicted different effects of these two forms of detritius because of the different nature in the organic material (specific gravity and chemical content) and the provision of shell material associated with mussel deposition. Mussels and *Ulva* were collected from artificial breakwaters located in Lido di Dante (44°22'59''N, 12° 19'19''E). Mussels were frozen for 24 hours while *Ulva* stored at 4° for 24 hours to quickly obtain fresh detritus, therefore disposed into net bags (60x60 cm, mesh size 1 cm) to be used in the experimental treatments. The experiment was set up on soft bottoms at about 50 m apart from any artificial structure and at a depth of 4 m which is similar to the depth of soft-bottoms surrounding the nearby structures. Treatments included: addition of detritus from *Ulva* spp (500 g wwt), addition of detritus from mussels (3 kg wwt), unmanipulated controls and a procedural control (empty nets). The amount of detritus in each treatment was chosen based on previous field observations. Twelve plots were established for each treatment. Sampling was done 2 days, 7 days and after 21 days after the deposition of the detritus to follow the temporal trajectories of the effects. Each time 4 plots of each treatment were randomly selected and sampled destructively. Variables measured in each plot included: soft-bottom macrofauna, macrofauna directly associated with the detritus, total organic matter, chlorophyll *a* and sediment grain size. Detritus originated from *Ulva* spp. and mussels had significant and different effects on macrofauna. These effects included both changes in the composition and distribution of the macrofauna in the sediments and effects related to the colonization of detritus by rich assemblages (particularly amphipods). Strong effects were evident 2 and 7 days after the beginning of the experiment, but weakened by 21 days. This suggests very rapid breakdown and assimilation of this material into the benthic foodweb. Some of the major changes were related to few families of amphipods that showed the highest abundance in *Ulva* treatments after 7 days of the starting of the experiment. Our study suggests that mounds of detritus produced by organisms associated to marine artificial structure can affect the structure of native soft-bottom assemblages. This effects become particularly significant if scaled up in areas, such the North Adriatic Sea, which is highly affected by marked eutrophication processes, frequent storm events and high temperature that could enhance detritus deposition around more than 300 km of coastline protected by artificial structures.

References

1 - Airoldi L. and Beck M.W., 2007. Loss, status and trends for coastal marine habitats of Europe. *Oceanogr. Mar. Biol.*, 45: 345-405.

2 - Davis N., VanBlaricom G.R., and Dayton P.K., 1982. Man-made structures on marine sediments: effects on adjacent benthic communities. *Mar. Biol.*,70: 295-303.

3 - Bertasi F.,Colangelo M.A., Abbiati M.,and Ceccherelli V.U., 2007. Effects of an artificial protection structure on the sandy shore macrofaunal community: the special case of Lido di Dante (Northern Adriatic Sea). *Hydrobiol*., 586: 277-290.

4 - Airoldi L., Abbiati M., Beck M.W., Hawkins S.J., Jonsson P.R., Martin D., Moschella P.S., Sundelöf A., Thompson R.C. and Åberg P., 2005. An ecological perspective on the deployment and design of low-crested and other hard coastal defence structures. *Coast. Eng*,.52: 1073-1087

5 - Glasby T.M. and Connell S.D., 1999. Urban structures as marine habitats. *Ambio*,28: 595-598.

6 - Bulleri F., 2005. The introduction of artificial structures on marine soft- and hard-bottoms: ecological implications of epibiota. *Environ. Cons.*,32: 101-102.

THE DEVELOPMENT OF A VULNERABILITY INDEX FOR BEACH EROSION, BASED ON A SEDIMENT BUDGET APPROACH

George Alexandrakis [1]*, Serafim Poulos [1] and Adonis Velegrakis [2]
[1] Department of Marine Science, University of the Aegean, University Hill, Mytilini 81100, Greece
[2] Faculty of Geology & Geoenvironment, Department of Geography & Climatology, University of Athens, 15784, Greece - g_alex@geol.uoa.gr

Abstract
The present contribution presents an erosion index for the beach zones based on a conceptual sediment budget model; the latter involves the identification of littoral cells, sediment sources, throughouts and sinks of sediment. For the development of the index the aforementioned parameters are ranked in a homogeneous way and interrelated mathematically. The produced index values quantify relatively vulnerability to erosion along the beach zone.
Keywords: Coastal Processes, Erosion, Shoreline Evolution

Introduction
The difficulty to predict coastline changes is due to the range and the frequency of processes that affect coastal areas and the closely coupled links between sea-level rise and other processes driving coastal change. Over the past decade, the Coastal Vulnerability Index has been developed for the assessment of coastline changes due to a potential sea level rise. This index aims to classify the potential effects of sea-level rise on open coasts using the physical characteristics of the coastal system (for details see Gornitz and White, 1992), providing basically a rank-based vulnerability assessment and comparative classification of the various coastal stretches.
The aim of this contribution is the development of an index dedicated to the assessment of vulnerability in the case of beach zones developed in microtidal environment but experiencing significant nearshore hydrodynamics including relative sea level change.

The BVI method
Concept: The proposed beach-zone vulnerability index (BVI) is based on a numerical approach of the parameters governed the sediment budget of beach zone and its evolution. Thus, variables that form the beach vulnerability index includes: (i) long-shore sediment transport; (ii) cross-shore transport; (iii) riverine inputs; (iv) relative sea level change (tectonic and climatic); (v) wave run-up; and, (vi) aeolian sediment transport. It is worth mentioned that the calculation of the aforementioned variables incorporates the estimation of other important parameters, such as granulometry, significant wave height and the gomorphological characteristics of the beach zone, like beach slope, beach profile length

Calculation: For the calculation of each variable the simplest possible available equation has been chosen; these are presented below:

(I). Longshore sediment transport is given by Komar's (1998) equation:

$$Q_1 = 1.1\rho g^{\frac{3}{2}} H_b^{\frac{5}{2}} cos(a_b) sin(a_b) \quad (1)$$

where, Q: potential volumetric longshore transport rate (m^3/day), ρ: water density; g: the acceleration of gravity; H_b: breaking wave height, a_b: wave crest angle at breaking.
(II) Crosshore sediment transport is provided from the Bailard and Inman's (1981) equation:

$$Q_1 = \rho C_D u_b^3 \left\{ \frac{\varepsilon_B}{tan\phi} \left(\psi_1 + \frac{2}{3}\delta_u - \frac{tan\beta}{tan\phi} u_3^* \right) + \frac{u_b}{w_s}\varepsilon_s \left[\psi_2 + \delta_u u_3^* - \frac{u_o}{w_s}\varepsilon_S u_3^* tan\beta \right] \right\} \quad (2)$$

where, ε_B: 0.2; ε_S: 0.025; C_D: dragging coefficient; w_s: sediment fall velocity; φ: the angle of repose; β: the beach slope; u_b:near bed water velocity; ρ: water density; and, ρ_s: density of sediment. δ_u,ψ_1, ψ_2, ψ_1, u_3^* and u_5^* cross-shore velocities depending from the significant wave height (Bailard ,1982).
(III) In the case of data absence, riverine sediment inputs maybe calculated with the use of Hovious' (1998) equation:

$$lnE = -0.416lnA + 4.26 \cdot 10^{-4} H + 0.15T + 0.095T_R + 0.0015R + 3.58 \quad (3)$$

Where, E: sediment weight gr/m^2; H: maximum elevation of the drainage basin; T: mean temperature; T_R: temperature range; and, R: river run off.
(IV) The effect of relative sea level rise variable is calculated from Bruun's (1962) semi-empirical relationship: $R = s\left(\frac{L}{B + h_c}\right)$ (4)
where, S: relative mean sea level rise, in cm; L: profile length; B: berm height; and, h_c:closure depth.
(V) The wave run-up R is given from CERC (1984) in the case of:
breaking waves, $R = 2.32 H_o \xi_o^{0.17}$ (5a) and,
non-breaking waves, $R = H_o\sqrt{2\pi}\left(\frac{\pi}{2B}\right)^{\frac{1}{4}}$ (5b)
where, Ho: offshore significant wave height; B: Berm height, and ξ: the Irribaren number.
(VI) The aeolian transport variable is provided by Hsu (1986) equation:

$$q = V_a P_a \left(e^{-0.63+0.91D}\right)\sqrt{\frac{U_x}{gD}} \quad (6)$$

where, *q:* sand transport rate, in gm/cm/s; *u**: shear velocity; *g:* acceleration of gravity; *D:* mean sand grain diameter; *Va:* air kinematic viscosity; and, *Pa:* air mass density.

The index is applied in a beach zone that is divided alongshore into a grid at distances according to the required accuracy. Subsequently, the required data set is obtained either by the use of numerical models (eg. wave heights, breaking height and angle) or by data that are collected by field measurements.
Ranking index variables: It is based on the assumption that the potential maximum value reflects 100% of the variable; this maximum value will be calculated obviously by applying the maximum values for the parameters that are included in the corresponding equations. Numerical values of variables will be also transformed into percentages ranging between 0.00 and 1.00, while those variables that are associated with addition and/or removal of sediment from the beach zone (e.g. cross-shore sediment transport will be signed as either negative or positive.
Output: The index will be calculated as the geometric mean value of the six (6) variables for each grid cell of the beach zone. This will highlight not only the most vulnerable parts of the beach zone to erosion, but also the principal variable being responsible for the highest vulnerability; thus, the physical process(es) mostly responsible for the erosion could be identified.

References
1 - Bailard J. A. and D.L. Inman., 1981. An energetics bedload model for a plane sloping beach: local transport *J. Geophys. Res.* 86(C3), 2035-2043.
2 - Bailard J.A., 1981. "An energetics total load sediment transport model for a plane sloping beach" *Journal of Geophysical Research*, Vol86 pp 10938-10954.
3 - Bruun, P., 1962. Sea-level rise as a cause of shore erosion: Proceedings, American Society of Civil Engineers, *Journal of Waterways Harbors Division*, v. 88, p. 117-130.
4 - Shore Protection Manual, (4th ed) 1984. 2 Vol, US Army Engineer Waterways Experiment Station (CERC), US Government Printing Office, Washington DC.
5 - Gornitz, V., and White, T. W., 1992. A coastal hazards database for the U.S. East Coast.: ORNL/CDIAC-45, NDP-043A, Oak Ridge National Laboratory, Oak Ridge, Tenn.
6 - Hovious N., 1998. Controls on sediment supply by large rivers. In: Relative Role of Eustacy, Climate, and Tectonism in Continental Rocks by K.W. Shanley and P.J. McCabe (eds), Special Publication, Society of Economic Paleontologists and Mineralogists, 59, 3-16.
7 - Hsu, S. A., 1986. Correction of Land-Based Wind Data for Offshore Applications: A Further Evaluation,*Journal of Physical Oceanography*, Vol 16, pp 390-394.
8 - Komar P.D., 1998. "Environmental Controls on Littoral Transport " 21st International Coastal Engineering Conference, American Society of Civil Engineers pp 1238-125.

THREE-DIMENSIONAL MATHEMATICAL MODEL TO SIMULATE GROUNDWATER FLOW AND MASS TRANSPORT IN COASTAL AQUIFER SYSTEM OF ANNABA, EASTERN ALGERIA

Badra Aoun Sebaiti [1]*, Erick Carlier [1] and Azzedine Hani [1]
[1] Ecole Universitaire Polytechnique de Lille - aounsebaiti-badra@hotmail.com

Abstract
On the coastline of the Seybouse low plain, the gravel aquifer is characterised by a high conductivity. In order to determine the origin of this salinity, a monthly monitoring of the groundwater chemistry was conducted between February and December 2006. The collected basic data were used for the preparation of a groundwater flow and mass transport model for the quantitative assessment of impact of human influence on contaminant dispersal in the watershed.
Keywords: Algerian Basin, Models, Pollution, Salinity

The potentiometric surface in the Seybouse basin, which covers an area of 264 km^2, has declined significantly since 1978. Earlier studies in this area (1-3) have shown that i) groundwater is used intensively near the coast; ii) the decrease of water levels creates piezometric depressions and the extension of zero level towards the south (Fig. 1); iii) the dip of the gravel strata is mainly towards the sea; and iv) the steady decrease of hydrochemical features from the sea to the continent on about 15 km (Fig. 2).

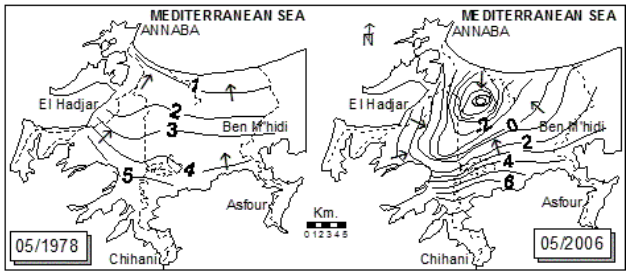


Fig. 1. Variation of piezometric levels between 1978 and 2006

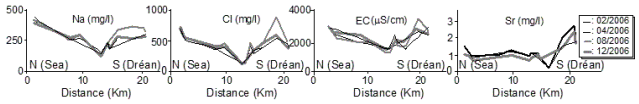


Fig. 2. Variations of hydrochemical features. Graphs for chlorides, sodium, Strontium and EC from the sea to Dréan, in southern sector

A transient multilayer model has been developed to synthesise the hydrologic data and study the regional changes in aquifer interactions caused by changes in discharge. The model consists of two layers, the first corresponding to the alluvial phreatic aquifer and the second to the deep confined aquifer, and it is calibrated against the steady state groundwater heads recorded before 1983. Model verification was done by history matching over the period 1978-1996. Under steady-state conditions, the correspondence between simulated and observed water levels is generally good (average difference of 0.4 m). For the deep aquifer, the simulated time-series hydrographs closely match the recorded hydrographs for most of the observation wells. For the alluvial aquifer, the recorded hydrographs cover only a short time period, but they are reproduced. The model indicates that groundwater pumping induced a decrease in natural discharge, a downward leakage in most of the basin and a continual water-level decline. The model has also been applied to the analysis of recharge impact. Simulating the behaviour of the system over the period 1978-1996 without pumping indicated small changes in hydraulic head. These results show that the groundwater reservoir has a low recharge, but excellent hydraulic properties; a solute-transport model was used to study aquifer contamination from salty intrusion in coastal sectors; it was extended to the year 2010 by simulating an optimistic hypothesis that maintains present pumping until 2010. The model indicates that the head decrease of the alluvial phreatic and deep confined aquifers will be 4 m and 5 m respectively. The simulated piezometric distribution illustrates the vulnerability of the aquifer in coastal sectors where flows with an important concentration of chloride may be observed, especially towards the Salines wells field. The solute concentration in the deep confined aquifer will increase from 1 g.L (prior 1996) to 5 g.L in 2010 m.

References
1 - Debièche T.H., 2002. Evolution de la qualité des eaux (salinité, acidité et métaux lourds) sous l'effet de la pollution saline, agricole et industrielle : Application à la basse plaine de la Seybouse, N.E. algérien. Thèse de Doc. de l'univ. de Franche-Comté, 200p.
2 - Aoun-Sebaïti, B., 2003. Processus de salinité et modélisation du système aquifère d'Annaba. Mém. de Magistère, Univ. de Annaba, 105 p.
3 - Lamouroux C. and Hani A., 2006. Identification of groundwater flow paths in complex systems aquifer. *Hydrol. Process.* 20, 2971-2987.

SPATIO-TEMPORAL CHANGES IN STRUCTURE AND FUNCTION OF THE COASTAL ECOSYSTEM IN THE NE BLACK SEA

E. Arashkevich [1]*, V. Chasovnikov [1], V. Kremenetskiy [1], S. Mosharov [1], A. Nikishina [1], L. Pautova [1] and K. Soloviov [1]
[1] Shirshov Institute of Oceanology, Russian Academy of sciences - aelena@ocean.ru

Abstract
We present hydrophysical, chemical and biological data obtained in the different seasons in the coastal zone of the NE Black Sea in 2007-2009. Spatial changes in chemical parameters (nutrients, DO, H2S) as well as in primary production, Chl a, POC, phyto- and zooplankton distributions are discussed in relation to hydrophysical conditions and the influence of coastal run-off. Seasonal peculiarities of ecosystem structure and function are described.
Keywords: Black Sea, Coastal Systems

Introduction
The pelagic ecosystem of the coastal area is characterized by a high spatio-temporal variability caused by the complicated physical, chemical, and biological processes running in this region [1]. To a great extent, this variability is related to the presence of fronts, eddies, filaments, etc, which control the intensity and directions of the along- and cross-shelf transport [2], [3]. Meanwhile, the hydrophysical processes occurring near the shore and over the continental slope cause a great diversity of scenarios, which switch depending on wind forcing and the regional climatic changes on both temporal and spatial scales [4], [5]. This study was performed in frame of EU project SESAME and aimed to investigate the coastal ecosystem function and cross-shelf exchange in the NE Black Sea.

Material and methods
In 2007-2009, monitoring of seasonal variations in physical, chemical, and biological parameters was performed in the coastal region off Caucasian coast. Data were collected along a transect from the shore to deep basin in three seasons, spring, summer, and autumn. CTD-profiling (by SBE 19plus probe) along with chemical (nutrients, DO, H2S) and biological (primary production, Chl a, POC, phyto- and zooplankton) sampling were done at three key stations located over the inner-shelf (25 m isobaths), middle-shelf (55 m isobaths) and continental slope (1000 m isobaths). Horizons for hydrochemical and biological sampling were chosen according to *in situ* CTD-profiles.

Results and discussion
The high amplitude of seasonal variations in the surface temperature (up to 19°C) caused the drastic changes in the structure of pelagic ecosystem. In winter/spring, the seasonal maximum of nutrients as well as Chl-a and primary production (PP) was observed in the upper 10-m layer. After the thermocline formation, the depletion of nutrients in the upper layer led to decrease in Chl-a concentration and PP. Species composition of phytoplankton showed significant seasonal changes with predominance of dinoflagellates in spring, coccolitophorids in summer, and diatoms in autumn but this pattern could vary from year to year. There was a slight tendency to the decrease of nutrients and phytoplankton concentration in the inshore-offshore direction, however the difference was insignificant. This finding suggests an intensive cross-shelf exchange in the study area. PP varied from 210±60 mg C/m^2 day in spring to 175±30 mg C/m^2 day in autumn. Two peaks of zooplankton abundance were observed in spring and autumn at all locations but their intensity differed in the different years. No obvious relationship between phytoplankton concentration and zooplankton biomass were found. The effect of gelatinous top-predators (medusas and ctenophores) on the total zooplankton biomass was insignificant at short-time, monthly, and interannual scales (ANOVA, F=2.34, p=0.1). The surface-dwelling zooplankton populations showed more prominent response to both hydrophysical changes and biological (food and predations) factors.

References
1 - Sanchez-Arcilla A. and Simpson J.H., 2002. The narrow shelf concept: couplings and fluxes. *Continental Shelf Res*., 22: 153-172.
2 - Sur, H.I., Ozsoy, E. and Unluata, U., 1994. Boundary current instabilities, upwelling, shelf mixing and eutrophication processes in the Black Sea. *Prog. Oceanog*., 33: 249-302.
3 - Zatsepin, A.G., Ginzburg, A.I., Kostianoy, A.G. *et al*., 2002. Variability of water dynamics in the northeastern Black Sea and its effect on water exchange between the nearshore zone and open basin. *Oceanology*, 42. (Suppl 1): S1-S15.
4 - Oguz, T., Cokacar, T., Malanotte-Rizzoli, P. and Ducklow, H.W., 2003. Climatic warming and accompanying changes in the ecological regime of the Black Sea during 1990s. *Global biochemical cycles*, 17: No. 3, doi:10.1029/2003GB002031.
5 - Arashkevich E.G., Drits A.V., Timonin A.G. and Kremenetskiy V.V., 2002. Variability of spatial zooplankton distribution affected by water dynamics in the north-eastern Black Sea. *Oceanology* V. 42 (Suppl. 1). P. S79-S94.

ETUDE COMPARATIVE DU RYTHME DE L'ACTIVITE LOCOMOTRICE DE *TALITRUS SALTATOR* ISSU DE DEUX PLAGES TUNISIENNES: BIZERTE ET GOLFE DE GABÈS

Amel Ayari [1]* and Karima Nasri-Ammar [1]
[1] Faculté des Sciences de Tunis, 2092, Tunisie - ayariamel@gmail.com

Abstract
L'amphipode supralittoral, *Talitrus saltator*, considéré comme bioindicateur de la stabilité des plages sableuses, a fait l'objet de plusieurs recherches concernant l'étude du rythme locomoteur. Notre étude a pour objectif de caractériser le rythme de l'activité locomotrice de ce talitridé au niveau de deux plages géomorphologiquement différentes. L'étude du rythme de l'activité locomotrice des animaux expérimentés a révélé plusieurs différences statistiquement significatives. Par ailleurs, les différences observées sont expliquées comme stratégie adaptative aux changements environnementaux.
Keywords: Crustacea, Gulf Of Gabes

Introduction
L'activité locomotrice présente une dépendance directe aux fluctuations des facteurs environnementaux qui sont considérés comme des synchroniseurs ou "Zeitgeber" [1]. En effet, le rythme circadien est entrainé par l'alternance jour/nuit [2] et le rythme circatidal est synchronisé par le flux et le reflux des marrées. Le but de ce travail est de comparer les caractéristiques du rythme endogène de *Talitrus saltator* au niveau de deux plages géomorphologiquement différentes.

Matériel et Méthodes
Un total de 30 individus ont été collecté, durant la saison automnale, aussi bien au niveau de la plage de Bizerte (37°19'N-9°51'E) qu'au niveau de la plage du golfe du Gabès (N 33° 52' 34,0''; E 10° 07' 38,8"), cette dernière présente une amplitude des marées considérée comme la plus importante dans le bassin méditerranéen (jusqu'à 2,2 m). L'activité locomotrice a été enregistrée en plaçant, individuellement, les spécimens dans des boites d'enregistrement ou actographes. Ces derniers sont placés dans une enceinte climatique qui permet de contrôler aussi bien la température que la photopériode. Les individus de *Talitrus saltator* ont été maintenus sous une température constante de 18 ± 0.5°C. Ces spécimens ont été d'abord, soumis à la photopériode naturelle (LD) du jour de la collecte puis ils ont été maintenus en libre cours (obscurité continue : DD).

Résultats et discussion
L'activité locomotrice des spécimens de *Talitrus saltator*, testés dans cette expérience, a révélé un rythme circadien proche de 24h avec une composante circatidale d'environ 12h (Tableau 1). L'étude de la rythmicité des individus a montré qu'au niveau des deux plages de Bizerte et du Gabès, la rythmicité circadienne est la plus prononcée quel que soit le régime photopériodique imposé (LD ou DD) ; la rythmicité circatidale est plus marquée au niveau de la plage du golfe du Gabès (Figure1). L'analyse des actogrammes en double plot, ainsi que les courbes d'activité locomotrice moyenne par heure et par jour, ont permis de mettre en évidence trois types de profils : unimodal, bimodal et plurimodal. Le rythme locomoteur des individus issus de la plage de Bizerte décrit un profil bimodal qui est le plus observé sous alternance lumière/obscurité. Par contre, en obscurité continue, le profil plurimodal est le plus dominant. Les individus collectés au niveau du golfe de Gabès présentent une activité locomotrice de type plurimodale quel que soit le régime photopériodique imposé. L'étude des caractéristiques du rythme de l'activité locomotrice (période circadienne, période circatidale, temps d'activité et déphasage Δf) a montré qu'en obscurité continue, la population de *Talitrus saltator*, provenant de la plage de Bizerte, présente un allongement d'une heure de la période circadienne ; alors que, la période circadienne obtenue chez les individus issus de la plage du golfe de Gabès reste inchangée sous les deux régimes photopériodiques [LD] et [DD]. Une différence hautement significative a été révélée entre les périodes circadiennes des deux populations (Tableau1). De plus, l'analyse statistique par le test Wilcoxon a révélé des différences significatives entre les périodes circatidales des deux populations, quel que soit le régime photopériodique imposé (Tableau1). L'analyse des temps d'activités n'a révélé aucune différence significative (Tableau1). Enfin, la majorité des individus de la population du Gabès présente un retard de phase alors qu'une avance de phase est observée pour *Talitrus salator* collectée au niveau de la plage de Bizerte. La différence entre les déphasages moyens des deux populations est hautement significative (Tableau1).

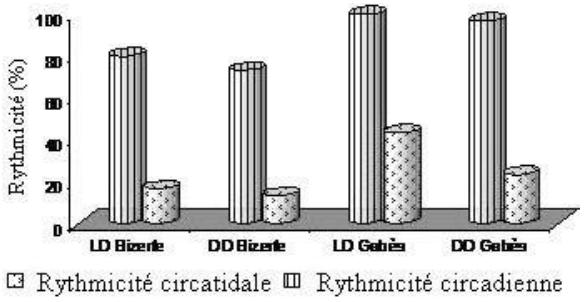


Fig. 1. Rythmicité en fonction des régimes photopériodiques des individus collectés dans les plages étudiées Bizerte et golfe de Gabès.

Tab. 1. Comparaison des caractéristiques du rythme locomoteur de *Talitrus saltator*. LD: alternance lumière/obscurité, DD Obscurité continue , ET: Ecart-type effectif

		BIZERTE	GABES	Test statistiques
Période circadienne ± e.t (N)	LD	23h54' ±0h53' (24)	23h57' ± 1h23' (30)	NS
	DD	24h53' ± 1h16' (22)	23h54' ±0h57' (29)	HS P= 0,003
Période circatidale ± e.t (N)	LD	11h40' ±0h28' (5)	12h05' ±0h43' (13)	S P= 0,027
	DD	13h35' ± 1h30' (4)	11h37' ± 1h20' (7)	S P= 0,035
Temps d'activité ± e.t	LD	705'± 230'	720'± 195'	NS
	DD	733'± 310'	700'± 263'	NS
Déphasage ± e.t		29' ± 143'	-75' ± 160'	HS P= 0,009

References
1 - Aschoff J., 1960. Exogenous and endogenous component in circadian rhythms. Cold Spr. Harb. Symp. Quant. Biol., 25, 11-28.
2 - Williams J.A., 1980. Environmental Influence on the locomotor activity rhythm of *Talitrus saltator* (Crustacea, Amphipoda*). Marine Biology, 57: 7-16.*

CHANGES IN THE MACROALGAL ASSEMBLAGE OF THE UPPERMOST INFRALITTORAL FRINGE FOLLOWING A POINT OIL SPILL IN THE GRAND HARBOUR, MALTA

Marthese Azzopardi [1]* and Patrick J. Schembri [1]
[1] Department of Biology, University of Malta, Msida MSD2080, Malta - marthese.azzopardi@um.edu.mt

Abstract
The uppermost infralittoral rocky shore macrophyte assemblage at Rinella Creek in the Grand Harbour, Malta was sampled in June 2002. Two days later, approximately 3.5 tonnes of oil were accidentally released at this site and the oil on the shore was cleaned up with steam. The site was visited 16 times over a period of 14 months to record the recolonisation process. Multivariate community analysis showed that the community had recovered within a year from the incident.
Keywords: Algae, Petroleum, Pollution, Rocky Shores

Introduction
On 24 June 2002, ~3.5 tonnes of oil were accidentally released from a discharge pipe on the shore by the Tank Cleaning Facility at Rinella Creek, within the Grand Harbour, Malta, resulting in an oil slick that extended from the point of discharge to approximately mid-way across the creek. The spill was contained by booms and the oil was removed within three days. Serendipitously, the shore at the spill site had been sampled two days prior to the spill, as part of another project. When the site was re-visited two days post-spill, the rocky shore was being cleaned of oil using steam. Drastic changes in the shore community as compared to conditions pre-spill were immediately evident, including bleaching of the dark band of supralittoral cyanobacteria, discoloration of mediolittoral macroalgae, and mass mortality of the mediolittoral fauna.

Methods
Five replicate 0.5 m x 0.5 m quadrats were placed at random in each of the supralittoral, upper and lower mediolittoral and uppermost infralittoral zones at Rinella Creek and the percentage cover of each species of macroalga was recorded. The site was visited 16 times over a period of 14 months to record the recolonisation process, however, no data were collected on two occasions due to bad weather. The quadrats were placed at exactly the same position during each sampling visit. The results presented here are for the macroalgae of uppermost infralittoral fringe (sea-level to 50 cm water depth).

Results & Discussion
Throughout the study period, 17 macroalgal taxa were recorded from the infralittoral fringe, comprising 5 Chlorophyta, 4 Phaeophyta and 8 Rhodophyta. Of these, 7 were perennials and 10 annuals. Eight species were filamentous, 6 were erect and 3 were encrusting. The lowest number of species recorded was 3, on the second visit and the highest was 11, a year after the spill. Prior to the spill, the macroalgal assemblage comprised 9 species, of which *Corallina elongata* and *Cystoseira compressa* were dominant in terms of percentage cover (87% and 16%, respectively); encrusting algae (two species of *Lithothamnion* and *Neogoniolithon notarisii*) had a 6.6% cover and all remaining species < 2%. Post-spill, the encrusting algae were not recorded from the study area in 57% of the visits, however, in the last visit (August 2003) they had not only reappeared, but had a percentage cover of 8.6% which was more than the pre-spill value. During the second (July 2002) and third (August 2002) post-spill visits, *Cladophora sericea* had 100% cover, but this value decreased until it was not recorded from the sixth visit (September 2002) onwards. In the last visit, two species, *Dictyota* sp. and *Gigartina acicularis*, that had not been present pre-spill or in subsequent sampling sessions, were recorded with a cover of <1%. In the last sampling session (August, 2003) 11 macroalgae were present of which, *Corallina elongata* and encrusting algae had the highest percentage cover: 59% and 8.6%, respectively. All macroalgae had a heavy epiphytic cover of diatoms, mainly *Coscinodiscus* spp., and *Ceramium gracillimum*. Although *Corallina elongata* was the only species present throughout the entire study period, its percentage cover varied and ranged from a minimum of 34.2% in August 2002 to 100% in May 2003. Also, bleaching of *C. elongata* was observed during August and September. NMDS ordination (Fig. 1) showed a clear cyclical pattern, indicative of macroalgal community recovery after one year from the incident, a result confirmed by the RELATE procedure for cyclicity in PRIMER version 6 [1] (Rho = 0.448, P = 0.1%). The Shannon-Wiener index *H'* (Fig. 2) calculated for each sampling visit decreased by the second visit (first post-spill visit) but a year later, it was restored to its original value.

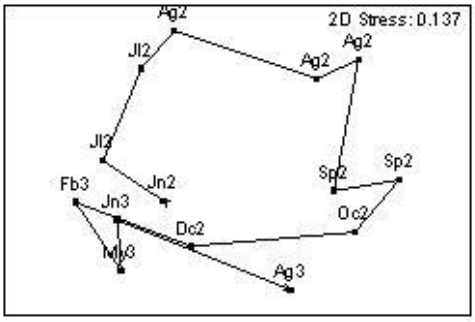


Fig. 1. NMDS ordination plot for infralittoral fringe macroalgal percentage cover from June 2002 (suffix 2) until August 2003 (suffix 3). (Jn – June; Jl – July; Ag – August; Sp – September; Oc – October; Dc – December; Fb – February; My – May)

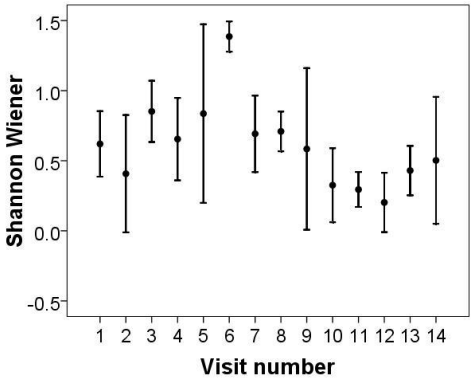


Fig. 2. Mean value and 95% confidence intervals of Shannon-Wiener index for each sampling visit at Rinella Creek.

References
1 - Clarke, K.R. and Gorley, R.N. 2006. *Primer v6: User Manual/Tutorial*. Primer-E, Plymouth: 190pp.

ASSESSMENT OF THE ECOLOGICAL STATUS OF MALTESE COASTAL WATERS USING THE RHODOPHYTA/PHAEOPHYTA MEAN RATIO INDEX (R/P RT. I.)

Marthese Azzopardi [1]* and Patrick J. Schembri [1]
[1] Department of Biology, University of Malta, Msida MSD2080, Malta - marthese.azzopardi@um.edu.mt

Abstract
Macroalgae from seven sites along the rocky upper infralittoral of Malta and Gozo were sampled in the spring, summer and winter seasons of 2003 and 2004. The aim was to apply the Rhodophyta/Phaeophyta mean ratio index (R/P rt. I.), a biological index which makes use of macroalgae, to discriminate between the sites, which are subject to different degrees of anthropogenic stress and which were therefore expected to have a different ecological status as defined by the EU's Water Framework Directive. The R/P rt. I. generally discriminated between sites, however, two sites gave anomalous results.
Keywords: Algae, Coastal Waters, Rocky Shores

Introduction
Benthic macroalgae are a reliable indicator of the trophic status of coastal waters and are one of the Biological Quality Elements for the evaluation of ecological quality required by the European Union's Water Framework Directive (WFD, 2000/60/EE). The aim of the present study was to apply the Rhodophyta/Phaeophyta mean ratio index (R/P rt. I.) [1], a biological index which makes use of macroalgae for the implementation of the WFD, to discriminate between seven sites in Malta, which are subject to different degrees of anthropogenic stress and which were therefore expected to have a different ecological status. Site locations included the Malta Freeport (a large transhipment centre), the Grand Harbour (considered highly eutrophic), and a reference site in Gozo.

Methods
Seven shores around Malta were selected to have the same substratum type and comparable slopes but different degrees of anthropogenic impact. Site selection was based on the results of a long-term monitoring programme of local inshore waters based on measurement of levels of nutrients, chlorophyll *a* and water transparency as indicators of environmental quality [2]. Five replicate 0.5 m x 0.5 m quadrats were placed at random in the upper infralittoral fringe (the zone from 0-50 cm depth) at each site and the percentage cover of each species of macroalga present was recorded three times a year in 2003 and 2004. For each site, the R/P rt. I. was worked out in three different ways, (i) for each season separately in 2003 and 2004, (ii) combining the annual seasonal data so as to produce a single value for each year, and (iii) over the whole two-year period. The results were analysed using non-metric multidimensional scaling (nMDS) and cluster analysis based on the Bray-Curtis similarity measure, and Principal Components Analysis (PCA). Computations were made using the PRIMER (ver 6) suite of programs [3].

Results & Discussion
PCA ordination based on environmental variables (Fig. 1) clearly distinguished the sites with PC1 and PC2 collectively explained 77.3% of the variation; PC1 appeared related to chlorophyll *a* content and BAC, and PC2 to dissolved phosphate. The sites could therefore be arranged in a series with Qbajjar as the reference site and, in order of deteriorating water quality, St. Paul's Bay, Marsascala-J, St. Angelo, Manoel Island, Birzebbuga and Marsascala-W. In total, 86 taxa were recorded, comprising 19 Chlorophyta, 24 Phaeophyta, 42 Rhodophyta and 1 Heterokontophyta. For each site, the same ecological status was obtained in 2004 as in 2003 when considering the respective annual macroalgal datasets. A cluster analysis and nMDS ordination were made on the percentage cover of Rhodophyta and Phaeophyta over the two-year period (Fig. 2). Three clusters resulted: (1) Qbajjar, St. Paul's Bay and Manoel Island with 'high' ecological status, (2) Marsascala-J and -W with 'low' status, and (3) St. Angelo and Birzebbuga with a 'bad' status. The St. Angelo site gave a consistently 'bad' status in all seasons during both years, due to a lack of Phaeophyta at this site. The same site groupings were obtained when calculating the R/P rt. I. Generally, the R/P rt. I. varied with season, for example, the ecological status for St. Paul's Bay was 'moderate' in spring 2003, 'bad' in summer and 'high' in winter. It may be concluded that the R/P rt. I. discriminated between sites, however, Marsascala-J and -W gave anomolous results since a 'moderate' ecological status was expected from the physico-chemical analysis and based on expert judgment; these sites had a high percentage cover of Chlorophyta, which distorted the index.

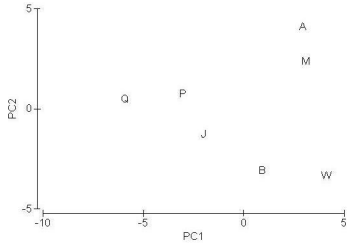


Fig. 1. PCA ordination of the sites based on mean values of salinity, temperature, dissolved nitrate, dissolved phosphate, Beam Attenuation Coefficient (BAC) and chlorophyll *a* content, recorded between 1998 and 2003 as given in [2]. (Q – Qbajjar; P – St. Paul's Bay; J – Marsascala-J; B – Birzebbuga; A – St. Angelo; M – Manoel Island; W – Marsascala-W).

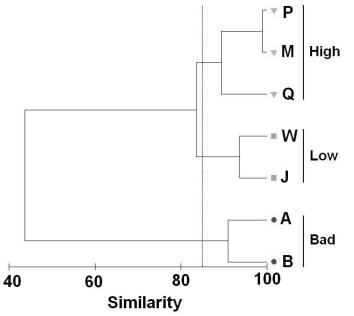


Fig. 2. Hierarchical group-average linkage clustering plots for the percent cover of Rhodophyta and Phaeophyta.(Site codes are as in Fig. 1)

References
1 - Giaccone, G. and Catra, M., 2004. Rassegna sugli indici di valutazione ambientale con macroalghe per definire lo stato ecologico delle acque costiere del Mediterraneo (Direttiva 2000/60/CE). *Biol. Mar. Medit.*, 11 (1): 57-67.
2 - Axiak, V., 2004. Monitoring rogramme for Coastal Waters. Seventh Report: June 2003, March 2004. Malta: unpublished report, Environmental Protection Directorate, Pollution Control Co-ordinating Unit, (Malta Environment and Planning Authority) and Marine Ecotoxicology Laboratory, Department of Biology (University of Malta): 70 pp.
3 - Clarke, K.R. and Gorley, R.N., 2006. Primer v6: User Manual/Tutorial. Primer-E, Plymouth: 190pp.

METHODOLOGIE POUR LE SUIVI DU TRAIT DE COTE DE LA REGION CENTRE D ALGERIE

Nour El Islam Bachari [1]* and Fouzia Houma [2]
[1] Université des Sciences et Technologie Houari Boumediene, Alger, 16111, Algérie - bachari10@yahoo.fr
[2] Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral, 16000, Alger, Algérie

Abstract
La région centre de la côte de l'Algérie a été exposée à plusieurs phénomènes naturels désastreux : séisme, sécheresse et inondation. Ces phénomènes ont des effets sur le trait de la côte ; dans certaines régions, il a avancé par contre, dans d'autre il a rétréci. En premier lieu nous avons tracé le trait de côte à différentes dates sur la base d'images satellites. Deux régions d'étude ont été analysées sur site.
Keywords: Coastal Waters, Deep Waters, Erosion, Sediment Transport

Introduction
La problématique posée est l'étude du recul et l'avancement de trait de côte dans la région Algéroise. Notre étude a porté sur la baie d'Alger et celle d'El Djamila, car dans ces deux baies, l'érosion et l'accrétion des plages ont pris de l'ampleur ces dernières années, surtout au niveau de l'érosion côtière. Ce phénomène devient une préoccupation environnementale majeure qui touche toute la façade centre de la côte algérienne. Pour cette étude, nous avons choisi des plages qui sont cibles de ces deux phénomènes.

Matériel et méthodes
Trait de côte. Pour réaliser les traits de côte nous avons utilisé des images hautes résolutions SPOT PANCHROMATIQUE pour les années 1988 et 1997. Nous avons transformé les images directement en trait de côte à partir d'un ensemble d'applications séquentielles effectuées sur la base de la morphologie mathématique. D'autre part des images du GOOGLE EARTH PRO sont utilisées. Pour cette partie, nous avons assemblé des images captées par écran en utilisant le logiciel Corel Draw. Pour réaliser cette opération nous avons utilisé environ 120 photos. L'ensemble des images est mis en table par le SIG MAPINFO9. Nous avons tracé le trait de côte par numérisation. Les trois traits de côte sont géolocalisés par rapport à des points fixes. L'analyse diachronique du trait de côte nous a permis de connaître l'état de changement et localiser les zones de grand intérêt [1], [2].
Cartes lithologiques, cartes des pentes et cartes des longueurs d'ondes de la houle. A partir des cartes géologiques nous avons réalisé des cartes de lithologie côtière. Grâce aux cartes topographiques, nous avons déterminé la distance entre le trait de côte et l'isobathe 10 m, cette distance est horizontale et perpendiculaire au trait de côte, la pente de chaque carreau a été calculée (chaque 250 m). On peut calculer la longueur d'onde des vagues sur une distance de 50 m à partir du trait de côte.
Commentaires des cartes. La carte lithologique montre l'existence de deux formes de lithologie côtière : des sables et galets qui sont des roches sédimentaires meubles, facilement transportables par les courants et les vagues. Ces sables forment la plage Est et la plage Ouest de Sidi Fredj. A l'arrière de ces plages on trouve des dunes actuelles, ces ensembles sont alimentés par l'Oued Béni-Messous et celui du Mazafran. L'isobathe des 10 m est très proche du trait de côte, en revanche, au niveau de la plage Est et de la plage Ouest cet isobathe s'éloigne du rivage. Ceci explique l'existence des fortes pentes face à la presqu'île de Sidi Fredj (des valeurs supérieures à 4 % sont enregistrées au carreau 23). Les faibles valeurs sont enregistrées au niveau des deux plages. Les zones de fortes pentes se caractérisent par des houles avec des longueurs d'ondes très élevées, elles subissent donc une houle de forte énergie, au contraire des zones à faibles pentes (plages) qui sont face à une houle d'énergie moins importante à cause de l'amortissement de l'énergie de la houle par le fond. La dureté du gneiss lui permet de résister à l'érosion causée par l'hydrodynamisme marin, par contre les sables des plages s'érodent facilement [3]. La plage Ouest est caractérisée par un degré d'érosion très élevé car elle est exposée à des houles, plus importantes et les plus violentes en période hivernale, qui viennent de l'Ouest et du Nord-ouest, contrairement à la plage Est qui est à l'abri des houles violentes et exposée à des houles de direction nord-est.
Accrétion côtière. Le site choisi dans cette étude, est une plage qui fait partie de la baie d'Alger et plus précisément se trouve dans la localité de Rais Hammidou du côté ouest de la baie. Nous avons pris des photos du transport sédimentaire ainsi que les mouvements des apports terrigènes véhiculés par les houles aboutissant à la formation des dépôts sédimentaires, généralement du sable varié - cette plage est sous la forme d'une baie semi-fermée qui piège le sédiment transporté par les vagues et les houles-. L'organisation des particules au moment du dépôt se traduit souvent par la formation de structures sédimentaires, d'autant plus variées que les forces en jeu sont diverses et changeantes [4]. De ce fait les structures sédimentaires les plus nombreuses et diversifiées s'observent sur les marges de la plage, où les influences climatiques, hydrologiques, biologiques, sont les plus actives et variables. La plage Ouest est caractérisée par un degré d'érosion très élevé car elle est exposée à des houles, les plus importantes et les plus violentes en période hivernale, qui viennent de l'ouest et du nord-ouest, contrairement à la plage Est qui, à l'abri des houles violentes et exposée à des houles de direction nord-est, n'est pas soumise à l'érosion marine.

Conclusion
Pratiquement, les zones côtières sont confrontées à des problèmes d'érosion et d'accrétion côtière. Ces problèmes pourraient s'accroître dans le futur en raison du changement climatique. Grâce à la télédétection spatiale, la détection des zones confrontées à ce problème peut s'effectuer rapidement. Les sorties sur terrain permettent une modélisation sous SIG et développer une analyse future. Cela permet une meilleure gestion du littoral et une protection durable du trait de côte.

References
1 - Bachari N., Belkessa R.,Houma F.,2004. Contribution of multispectral sate imagery to the bathymetric analysis of coastal sea bottom. MWWD -3 International Conference on Marine, Environnement Catania 27-9/2-10.
2 - Bachari NEI.,2008. Development of a tool integration marine data and satellite image INOC 2007 KISH I 03-05/12/ 2008IRAN
3 - Maouche. S.,1987. Mécanismes hydro-sédimentaires en baie d'Alger, Approche sédimentologique, géochimie et traitement statistique. Thèse de Doctorat, Université. Perpignan. 1987.
4 - Zviely a, E. Kit b, M. Klein Longshore sand transport estimates along the Mediterraneancoast of Israel in the Holocene. *Marine Geology* , 238 (2007) 61–73

DONNEES ECOLOGIQUES SUR LA NOUVELLE ESPECE *POMATIAS ELEGANS* (GASTEROPODE, PROSOBRANCHE, *POMATIIDAE* MULLER, 1774) TROUVEE AU NORD DE LA TUNISIE

Monia Ben Romdhane [1]*, Chahrazed El Hedfi [1] and Mohamed Ben Salem [1]
[1] Faculté des Sciences de Tunis, 2092, Tunisie - romdhanmonia@yahoo.fr

Abstract
Les variations mensuelles de la structure de la population de *Pomatias elegans* révèlent une dominance des femelles par rapport aux mâles ($X^2 = 5.36$). Les individus immatures présentent deux pics très nets au printemps et en automne, le premier pic est le plus élevé. L'espèce est rare en hiver et en été, mais elle est présente en automne et au printemps. Le sex-ratio global est biaisé en faveur des femelles.
Keywords: Mollusca, Reproduction

Introduction
Les Prosobranches terrestres n'ont fait l'objet d'aucune étude en Tunisie, et s'avèrent par conséquent extrêmement mal connus [1], [2]. La signalisation d'une nouvelle espèce au nord du pays améliore nos connaissances et augmente le nombre d'espèces de prosobranches terrestres tunisiens [3]. La répartition de *Pomatia elegans* est plus étendue en Europe (en Espagne [4], en France [5], en Italie [6] ainsi qu'en Turquie [7]). En Afrique, elle a été récemment signalée, seulement en Tunisie. Ce travail apporte des données à la connaissance de l'écologie et de la biologie de cette espèce.

Matériel et méthodes
Le site d'étude est situé au nord-est de la Tunisie (Raf-Raf : 37°11' ; 10°11'), les escargots sont prélevés à la main de leur milieu naturel. Pour chaque sortie, on compte le nombre de femelles, de mâles ainsi que celui des immatures ; puis on les place dans des récipients numérotés et étiquetés. Au total, l'effectif des individus collectés est égal à 203 spécimens. A ces individus nous avons appliqué le test Chi 2($\chi^2 = \sum_{i=1} x\ (a_1 - \alpha_i)^{2} / \alpha_i$ au seuil 5%), l'abondance relative AR (AR% = ni x 100/ N) et la fréquence d'occurrence F (F = n x 100/N).

Résultats et discussion
La structure de la population de *Pomatias elegans*
L'effectif total est de 203 spécimens dont 23.64 % mâles, 34.48 % femelles et 41.87 % indifférenciés. Faible en hiver (17 individus), le nombre s'élève à 109 individus au printemps avec un maximum en mai (41 individus). Pendant la période estivale, nous avons collecté uniquement 12 individus, alors qu'en automne, l'effectif augmente à 64 dont 28 sont des indifférenciés. Les variations mensuelles montrent une dominance des femelles par rapport aux mâles (70 femelles par rapport à 48 mâles). Cette dominance est nette dès le mois de février et durant le printemps. Les immatures présentent deux pics très nets au printemps et en automne, le premier pic est le plus élevé (Fig. 1).

L'abondance relative et la fréquence d'occurrence
L'abondance relative de la population de *Pomatias elegans* est faible en hiver ainsi qu'en été, à l'exception du mois d'août (0 individu). Les valeurs de l'abondance relative sont inférieures à 5 %, l'espèce est donc rare. En revanche, l'abondance relative augmente régulièrement pendant les mois du printemps (20,2 % en mai), mais elle reste toujours inférieure à 30 %. *Pomatias elgans* est considérée comme une espèce présente pendant les saisons printanière et automnale. La valeur de la fréquence d'occurrence est égale à 91,66 %, l'espèce est commune.

Le sexe- ratio
La valeur calculée de X^2 global (5.36) est supérieure à la valeur de X^2 théorique, l'écart entre les proportions des mâles et des femelles est significatif. Pendant l'hiver et l'été, le sex-ratio est biaisé en faveur des femelles, par contre, il est respecté au printemps et en automne.

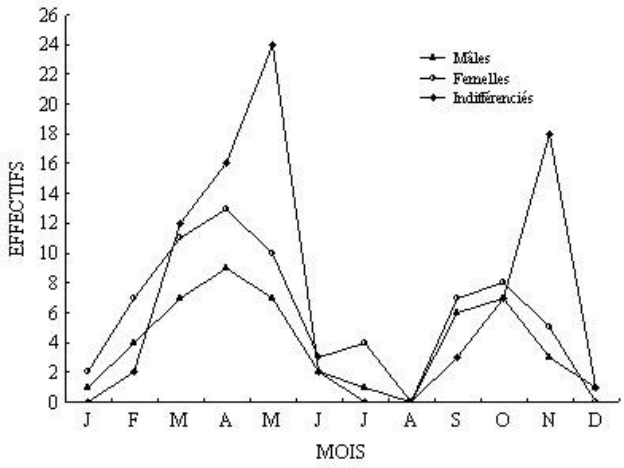


Fig. 1. Variations mensuelles des différentes catégories de la population de *Pomatias elegans* de Raf-Raf

References
1 - Ktari M.H. et Rezig M., 1976. La faune malacologique de la Tunisie septentrionale. *Bull. Soc. Sc. Nat. Tunisie*, 11 : 31-74.
2 - Abbés I., 2006. Biodiversité des gastéropodes terrestres en Tunisie septentrionale. Mémoire du Mastère. *Faculté des Sciences de Tunis*, 150 p.
3 - Ben Romdhane M., El Hedfi C. et Ben Salem M. 2008.Première mention de *Pomatias elegans*(O.F. Muller, 1774**)** (Gastropoda, *Pomatiidae*) au Nord de la Tunisie. *Malacologie*, 5 : 1-2.
4 - Martinez-Orti A. et Robles F., 2005. Los Caenogasteropodos Terrestres (Mollusca,Orthogastropoda) de la Comunidad Valenciana (Espana). *Iberus*, 23 (2) : 7-24.
5 - Kerney M.P. et Cameron R.A.D., 1979. A field guide to the land snails of Britain and North-West Europe. Collins. London. 415 p.
6 - Platts E., Bailey S. McGrath D. et McGeough G., 2003. A survey of the land winkle *Pomatias elegans* (Muller, 1774) in the Burren. *Royal Irish Academy*, 103 (3) : 197-201.
7 - Orstan A., Peace T.A. et welter-Schutes F., 2005. Land snail diversity in a threatened limestone district near Istanbul, Turkey. *Museum de Ciències Naturals*, 28 : 181-188.

OBSERVATIONS ON *PSEUDO-NITZSCHIA* SPECIES IN THE BAY OF KOTOR, SE ADRIATIC SEA

Suncica Bosak [1]*, Lucija Horvat [2], Branka Pestoric [3] and Sladjana Krivokapic [4]
[1] University of Zagreb, Faculty of Science, Division of Biology, Zagreb, Croatia - sbosak@biol.pmf.hr
[2] Rudjer Boskovic Institute, Department of Molecular Biology, Zagreb, Croatia
[3] Institute of Marine Biology, Kotor, Montenegro
[4] University of Montenegro, Faculty of Science, Department of Biology, Podgorica, Montenegro

Abstract
The diatom genus *Pseudo-nitzschia* includes several species capable of producing the neurotoxin domoic acid, the causative agent of Amnesic Shellfish Poisoning (ASP). The scope of this study was to identify species present in the Bay of Kotor, SE Adriatic Sea from the samples collected during the 2008/2009 survey. TEM examination revealed presence of four morphotypes: P. *pseudodelicatissima*, P. cf. *pseudodelicatissima*, P. *calliantha* and P. *subfraudulenta*.
Keywords: Diatoms, Adriatic Sea, Phytoplankton

Introduction
Marine planktonic pennate diatoms of the genus *Pseudo-nitzschia* are widespread and abundant in coastal and oceanic waters all over the world. The genus has received much attention following the discovery that some species are capable of producing the neurotoxin domoic acid, the causative agent of Amnesic Shellfish Poisoning (ASP). There are a few reports about occurrence and ecology of these diatom species from the southern Adriatic coastal waters [1] but none from the Bay of Kotor, a deeply indented bay located in the south eastern coast. This paper represents the first detailed report on findings of Pseudo-nitzschia species in this area.

Material and methods
Sampling was carried out seasonally in 2008/2009 at three stations in the innermost part of the Bay of Kotor. Water samples were collected with Niskin bottles and sub-samples for phytoplankton analysis preserved with neutralized formaldehyde at a final concentration of 1.4%. Phytoplankton composition was identified and enumerated according to Ütermohl. Transmission electron microscope (TEM) observations were made by deposition of acid cleaned material onto firmware metal grids and examination with a Zeiss EM10A microscope.

Results and discussion
The *Pseudo-nitzschia* species found in the Kotor Bay were identified with light microscopy as members of the P. *delicatissima* and P. *seriata* group, based on their valve width (1.5 – 2.8 µm and 4.3 - 6.7 µm, respectively). The cell ends in girdle view were pointed and elongated in the former morphotype therefore it was identified as P. *pseudodelicatissima* species complex. The latter was designated as P. *subfraudulenta* species from the P. *fraudulenta/subfraudulenta* group based on the shape of the valve which was more linear in the mid valve than lanceolate [2]. The cell length range was 85.6 - 195.6 µm. The overlap of cell ends was 1/6-1/4 of cell length. Upon TEM examination, specimens showed 13–17 fibulae and 22–28 striae in 10 µm. The central larger interspace was present and had the width of 5 valve striae. Each stria was biseriate with roundish poroids divided in several sectors separated by smooth space (6 - 7 in 1 µm). The ultrastructural features of the frustules confirmed the species as P. *subfraudulenta* (Hasle) Hasle (Fig. 1. A). Based on the ultrastructural features visible in TEM, P. *pseudodelicatissima*-like specimens were attributed to three distinct morphotypes. Only one morphotype was present in the samples collected in the spring period and together with P. *subfraudulenta* in autumn and winter samples. The cell length range of these cells was 14.3 – 76.8 µm and they overlapped in chains in 1/10 - 1/5 of cell length. Valves had 18 - 22 fibulae and 38 - 40 striae in 10 µm with presence of the central interspace. Each stria was ornamented with square poroids (5 poroids in 1 µm) split into 7 - 10 sectors with central sector present in more than 70% of the poroids. According to these features cells belonging to this morphotype were ascribed to P. *calliantha* Lundholm, Moestrup et Hasle (Fig. 1. B). Second and third morphotype co-occurred in the samples with measured cell length range of 38.9– 144.1 µm and overlap 1/12-1/7 of cell length. The shape of the valve was more linear in LM therefore it was not identified as P. *cuspidata* which has more lanceolate shape of the valves [2]. In TEM specimens of the second morphotype were designated as P. *pseudodelicatissima* (Hasle) Hasle emend. Lundholm, Hasle et Moestrup (Fig. 1. C). Cells had 40 - 44 striae and 22 - 26 fibulae in 10 µm. Striae were uniseriate with 4 - 6 oval to square poroids in 1 µm. In more than 50% of poroids hymen was divided into two large parts. However, in the same samples specimens were present with higher percentage of poroids divided into more sectors (4 - 6). These are not typical features of P. *pseudodelicatissima* and these cells had 40-44 striae and 20-22 striae per 10 µm. Given the possibility that these specimens belong to different species this third morphotype was refered to *P.* cf. *pseudodelicatissima* (Fig.1. D).

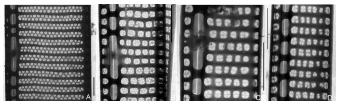


Fig. 1. TEM images: (A) P. subfraudulenta, (B) P. calliantha, (C) P. pseudodelicatissima(D) P. cf. pseudodelicatissima

P. pseudodelicatissima (both second and third morphotype) was found only in the summer with cell concentrations in surface waters of 1.2 x 10^5 cells L^{-1} and it contributed up to 70% of the microphytoplankton. P. *fraudulenta* and potentially toxic P. *calliantha* [4] were present in lower concentrations during the rest of the year with abundances up to 10^4 cells L^{-1} constituting up to 29% and 50% of microphytoplankton, respectively. The cell numbers and environmental parameters for each season are given in Tab 1.

Tab. 1. Seasonal range (min - max) and mean±SD of physical and biological parameters. For all abundance values minimum was 40 cells L^{-1}.

	spring	summer	autumn	winter
Temperature (°C)	14.1 – 15.4 (14.8 ± 0.5)	27.4 – 27.9 (22.3 ± 3.9)	14.6 – 15.9 (17.4 ± 1.6)	12.7 – 14.7 (12.5 ± 0.9)
Salinity	3.2 – 36.0 (26.1 ± 10.7)	28.0 – 36.2 (33.0 ± 2.8)	8.2 – 36.6 (28.6 ± 10.6)	10.1 – 37.0 (31.2 ± 8.5)
Oxygen saturation (%)	67 – 88 (75 ± 7)	104 – 114 (105 ± 4)	85 – 95 (90 ± 3)	61 – 71 (68 ± 2)
Chl *a* (µg L^{-1})	0.2 – 1.1 (0.6 ± 0.3)	0.09 – 1.4 (0.4 ± 0.4)	0.09 – 1.7 (0.7 ± 0.9)	0.3 – 1.9 (0.7 ± 0.4)
Microphytoplankton (cells L^{-1})	1.0×10^3 (0.2×10^3 – 4.8×10^3)	1.8×10^5 (0.1×10^5 – 1.1×10^5)	8.9×10^3 (1.8×10^3 – 1.9×10^4)	1.2×10^4 (2.8×10^3 – 3.8×10^4)
Diatoms (cells L^{-1})	3.9×10^3 (0.6×10^3 – 8.5×10^3)	2.6×10^5 (0.8×10^5 – 9.5×10^5)	1.7×10^4 (1.1×10^4 – 2.2×10^4)	1.2×10^5 (1.8×10^4 – 3.9×10^5)
Pseudo-nitzschia seriata group (cells L^{-1})	n.d.	n.d.	6.8×10^3 (0.9×10^3 – 1.6×10^4)	1.9×10^4 (1.2×10^4 – 5.2×10^4)
Pseudo-nitzschia delicatissima group (cells L^{-1})	1.6×10^3 (1.3×10^3 – 1.8×10^3)	1.2×10^5 (1.6×10^4 – 9.1×10^4)	7.3×10^3 (1.2×10^3 – 1.9×10^4)	4.2×10^3 (7.8×10^2 – 1.3×10^4)

Pseudo-nitschia calliantha, a species for whom the production of domoic acid is well documented [3], represents frequent component of the Kotor Bay phytoplankton assemblages. Blooms of this species are known from Italian coastal waters [1] as well from the middle eastern Adriatic coast [4] and despite the fact that in this investigation it was not recorded in high abundances, it is most likely that blooms of this species occur in these waters. Examination of *Pseudo-nitzschia* species distribution and related environment factors that affect their abundance are therefore essential for predicting potentially harmful algae blooms in the area as it sustains active shellfish farming.

References
1 - Caroppo C., Congestri R., Bracchini L. and Albertano P., 2005. On the presence of Pseudo-nitzschia calliantha Lundholm, Moestrup et Hasle and Pseudo-nitzschia delicatissima (Cleve) Heiden in the Southern Adriatic Sea (Mediterranean Sea, Italy). *J. Plankton Res.*, 27: 763-774.
2 - Hasle G.R., Lange C.B. and Syvertsen E.E., 1996. A review of Pseudo-nitzschia, with special reference to the Skagerrak, North Atlantic, and adjacent waters. *Helgolander Meeresun.*, 50: 131-175.
3 - Besiktepe S., Ryabushko L., Ediger D., Yilmaz D., Zenginer A., Ryabushko V. and Lee R., 2008. Domoic acid production by Pseudo-nitzschia calliantha Lundholm, Moestrup et Hasle (bacillariophyta) isolated from the Black Sea. *Harmful Algae*, 7: 438-442.
4 - Buric Z., Vilicic D., Caput-Mihalic K., Caric M., Kralj K. and Ljubesic N., 2008. Pseudo-nitzschia blooms in the Zrmanja River estuary (Eastern Adriatic Sea). *Diatom Res.*, 23: 51-63.

DIVERSITÉ MORPHOMÉTRIQUE DE *PATELLA CAERULEA* (LINNAEUS, 1758) DU LITTORAL ROCHEUX DES CÔTES TUNISIENNES

Jihen Boukhicha [1], Sabiha Zouari Tlig [1]* and Oum Kalthoum Ben Hassine [1]

[1] Unité de Recherche de Biologie, Ecologie et Parasitologie des Organismes Aquatiques, Campus Universitaire de Tunis, El Manar I, 2092, Tunisie - s.zouaritlig@gmail.com

Abstract

L'étude morphométrique de 200 individus de *P.caerulea,* peuplant deux étages différents (l'horizon supérieur du médiolittoral et l'horizon supérieur de l'infralittoral) du littoral rocheux des côtes de Korbous (golfe de Tunis), semble révéler l'existence d'une variation morphologique de la coquille associée à la distribution verticale. Les patelles du médiolittoral supérieur auraient probablement besoin de développer une coquille plus haute et une radula plus robuste leur permettant de s'adapter aux importantes fluctuations de facteurs environnementaux.

Keywords: Gastropods, Mediolittoral, Infralittoral, Mediterranean Ridge

Introduction

Patella caerulea est une espèce endémique de Méditerranée. Elle colonise, avec les autres espèces de patelles, le littoral rocheux. Comme toutes les autres espèces de ce genre, *P. caerulea* montre une grande plasticité morphométrique. Cette dernière représenterait une stratégie adaptative aux importantes fluctuations de facteurs environnementaux [1]. Dans cette étude, nous nous proposons d'analyser la diversité morphologique de *P. caerulea* peuplant deux étages différents du littoral rocheux des côtes de Korbous (golfe de Tunis), à savoir l'horizon supérieur du médiolittoral et l'horizon supérieur de l'infralittoral.

Matériel et Méthodes

Au total, 200 individus de *P. caerulea* ont été prélevés, à raison de 100 individus au niveau de chaque étage (horizon supérieur du médiolittoral, horizon supérieur de l'infralittoral) du site de Korbous (golfe de Tunis). Pour chaque spécimen de *P. caerulea*, cinq mensurations métriques ont été relevées à l'aide d'un pied à coulisse électronique au 1/100ème près : longueur (L), hauteur (H), distance entre le sommet et le bord antérieur (Apa), distance entre le sommet et le bord postérieur (App) et longueur de la radula (Lr). Les droites de régression ont été établies, à partir des valeurs de ces caractères transformés en log et en choisissant comme variable de référence la longueur de la coquille (L). L'évaluation des similitudes et des différences, pour un caractère donné chez les spécimens des deux étages, a été estimée par l'analyse de la variance globale ANOVA et le test de Fisher.

Résultats et discussion

Les résultats obtenus ont montré l'existence d'une étroite corrélation entre les différents paramètres étudiés (R > 0,9). L'analyse de la variance (ANOVA), appliquée aux rapports (In Lr) / (In L), (In H) / (In L), (In App) / (In L) et (In Apa) / (In L), a révélé des différences significatives entre les deux droites de régression relatives d'une part, aux échantillons du médiolittoral supérieur et, d'autre part, à ceux de l'infralittoral supérieur ($p < 0,05$). Ces résultats semblent indiquer que la hauteur de la coquille (H) et la longueur de la radula (Lr) des patelles habitant le médiolittoral supérieur sont beaucoup plus importantes que celles peuplant l'infralittoral supérieur (Fig.1), les premières ont, en outre, un sommet décalé vers l'arrière (Fig.2)

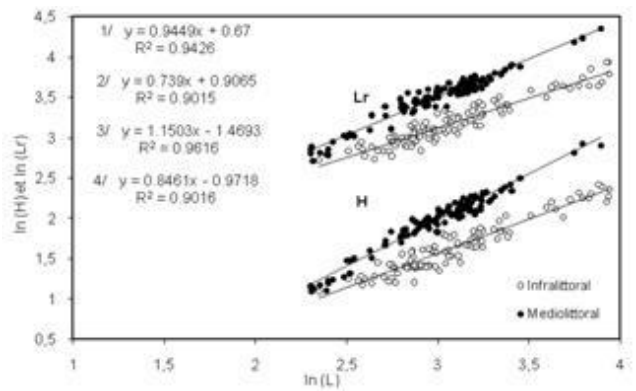


Fig. 1. Relation entre ln (Lr) et ln (L) et ln (H) et ln (L)

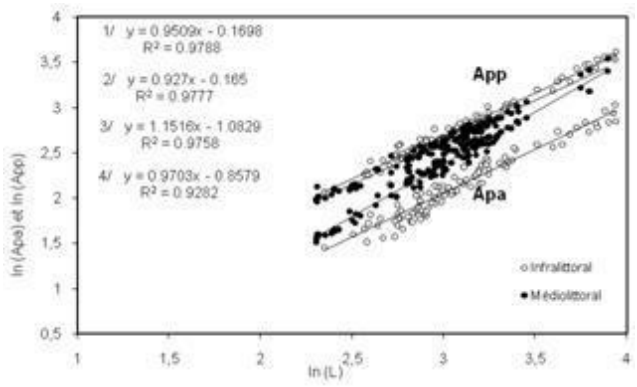


Fig. 2. Relation entre ln (App) et ln (L) et ln (Apa) et ln (L)

Ainsi, les patelles vivant au niveau du médiolittoral supérieur semblent développer une coquille plus haute afin de retenir une quantité d'eau plus importante. Ceci confirme les travaux de Balaparameswara Rao et Ganapati [2] qui ont signalé, chez l'espèce *Cellana radiata*, une différence morphométrique en relation avec la distribution verticale des individus et ont attribué cette plasticité morphométrique aux conditions de la dessiccation. Quant à la différence de la longueur de la radula, elle pourrait être en relation avec la nature différente du couvert algal des deux étages [3]. Les patelles du médiolittoral supérieur auraient probablement besoin de développer une radula plus robuste leur permettant de brouter les algues encroûtantes qui sont plus fréquentes à ce niveau.

References

1 - Cretella M., Scillitani G., Toscano F., Tirella and Picariello P., 1990. Comparative morphology of soft parts of Patella L. 1758 from the bay of Naples (Gastropoda: Patellidae). *Biol. Malacol.* 205-210.

2 - Balaparameswara Rao M., and Ganapati. P. N., 1971. Ecological studies on tropical limpet, *Cellana radiata*. Structural variations in shell in relation to distribution. *Mar. Biol.* 10: 236-243.

3 - Della Santina P., Sonni C., Sartoni G., and Chellazi G., 1993. Food availability and diet composition of three coexisting Méditerrannean lipmets (*Patella ssp*). *Mar. biol.* 116: 87-95.

RESEARCH TOOLS FOR TEACHING: A SCIENTIFIC PATH FOR 14 YEAR-OLDS TO UNDERSTAND MARINE ACIDIFICATION OCEAN ACIDIFICATION: BRING RESEARCH INTO CLASSROOMS

Fulvia Bradassi [1]*, Francesco Cumani [1] and Guido Bressan [1]
[1] University of Trieste - Life Sciences Department, 34100, Italy - FULVIA.BRADASSI@phd.units.it

Abstract
The fact that marine water is becoming more acidic because of the rising of atmospheric CO_2 partial pressure seems to be almost unknown to the public. A partnership with a middle school was established to fulfil the gap between research and the educational system. An experimental course on global climate change and ocean acidification was offered to 14 years-old pupils. The course, experimentally based on thallus of calcareous red algae grown under different acidic conditions, represents not only a way to spread knowledge on global climatic change among teenagers, but also a tool to measure how much new methods of teaching can improve scientific knowledge and skills at school.
Keywords: Algae, Global Change, Ph

Ocean acidification seems to be one of the most likely consequences of the increase of atmospheric CO_2 partial pressure, causing a remarkable change in the marine environment. [1]. Although ocean acidification might have great impacts, the phenomenon is still not well known and is almost unknown to the public. Our research team is focusing on the biological response of calcareous red algae (*Corallinaceae*) to ocean acidification [2]. The *Corallinaceae* play a fundamental ecological role in different marine ecosystems, from tropical reefs to high latitude cold waters. Different evidence, supported by vast and recent literature, suggest that, depositing mainly high-Mg calcite into their cell-walls, the *Corallinaceae* may be more susceptibile to ocean acidification than other calcifiers [3]. Since we believe that education can play a key role in changing habits of new generation, regarding anthropic CO_2 emission and ocean acidification prevention, we decided to build a link between researchers and school. Thanks to specific skills in teaching that some members of our group developed for previous working experiences, and thanks to the support of C.I.R.D. (Interdipartimental Centre on Didactical Research – University of Trieste) we established a partnership with a middle school in town. We offered an experimental course on global climate change and ocean acidification to 14 years-old pupils. The experiment, based on thallus of *Lithophyllum incrustans* Philippi (1837) demonstrates that a lower pH than actual (7.8 versus 8.2) influences the growing rate and even the morphogenetic development of microscopical thalli. We randomly chose 21 students from all the 3rd classes of the schools and offered them to join the project, attending a course of 25 hours. Another 21 students, not taking part in lessons, represented the control group. The course was based on experimental observation of the growing of microscopical thallus, from spores released in the 1st day of culture until 14th day. The pupils learned to treat two 20-liter marine aquariums in which they grew the algae. In the first tank the pH value was the natural one (8.2), while in the second the pH value was mantained lower (7.8) through CO_2 insufflation. Pupils also learned to use instruments, to collect qualitative and numerical data, to represent the data, to elaborate them, and to take conclusion from the outcoming. The personal engagement of the students, achieved through self-motivation, plays a fundamental role into the learning process: it is supposed that the girls and boys, attending to this course should develop their scientifical knowledge and skills, including scientific language,more than control group [4]. All the students have been tested at the beginning of the school year, and will be at the end, to estimate previous skills and knowledge and homogeneity between the two tested groups. The scientific abilities and knowledge taken as terms of reference are those fixed by OCSE – PISA (*Organizzazione per la Cooperazione e Sviluppo Economico* - Programme International Student Assessment) for 14 years old students. The OCSE standard [5] is compared to the italian ministerial standard [6], recently revised and updated.

References
1 - Hall-Spencer J. M., Rodolfo-Metalpa R., Martin S., Ransome E., Fine M., Turner S.M., Rowley S.J.,Tedesco D. & Buia M.C., 2008. Volcanic carbon dioxidevents show ecosystem effects of ocean acidification. *Nature* 454: 96-99.
2 - Cumani F., Di Pascoli A., Bressan G., 2008. Osservazioni fenoecotipiche di bioindicatori in coltura di laboratorio *Pneophyllum fragile* Kützing e *Hydrolithon boreale* (Foslie) Chamberlain (Corallinales, Rhodophyta). *Biol. Mar. Mediterr*., 15 (1): 260-261.
3 - Kuffner I. B., Andersson A. J., Jokiel P. L., Rodgers K. S., Mackenzie F. T., 2007. Decreased abundance of crustose coralline algae due to ocean acidification. *Nature*: 1-4.
4 - Randler C., Bogner F.X., 2009. Efficacy of two different instructional methods involving complex ecological content. *International Journal of Science and Mathematics Education National Science Council, Taiwan* 7: 315-337.
5 - OCSE., 2007. Valutare le competenze in scienze, lettura e matematica. Quadro di riferimento di PISA 2006. Roma, Armando ed. pp. 11-22; pp 25-54; pp 135-198.
6 - Ministero della Pubblica Istruzione., 2007. Indicazioni per il curricolo per la scuola dell'infanzia e per il primo ciclo d'istruzione. Ed. Ministero Pubblica Istruzione. Roma 111 pp.

HIGH EFFICIENCY FEEDING STRATEGY OF *TURSIOPS TRUNCATUS* IN THE FISHING GEAR DEPREDATION.

G. Buffa [1], G. Buscaino [1]*, A. Bellante [1], F. Filiciotto [1], C. Buscaino [1], A. Adamo [1], P. Labruzzo [1] and V. Di Stefano [1]
[1] IAMC/CNR U.O.S. di Capo Granitola - giusy.buscaino@cnr.it

Abstract
Some feeding strategies of Bottlenose dolphin appear to be associated to human activities, allowing dolphins to catch prey at a low energetic cost. A comparison study on three different artisanal fishing gears depredated by a *Tursiops truncatus* population was the objective of this work. Two monofilament nets named "Sgammerrara" (Sg1, Sg2) and one trammel net were used. An analysis of the collected data set suggests that the phenomenon of depredation is an example of *Tursiops truncatus* high behavioural plasticity and ability to discriminate between different opportunities, choosing those providing greater benefits.
Keywords: Fisheries, Coastal Systems, Competition, Diet, Behaviour

Introduction
Some feeding strategies of Bottlenose dolphin appear to be associated to human activities allowing dolphins to catch preys at a low energetic cost. The bottlenose dolphin diet is varied and often includes many fishes that are the target species of small-scale fisheries [1]. The "Operational Interaction" with artisanal fisheries is a serious problem because of attacks to nets and the economic damages for fishermen [2]. A comparative study on three different artisanal fishing gears depredated by a Tursiops truncatus population is the objective of this work.

Materials and methods
The study was carried out on November 2005 inside the Ognina bay (South-East Sicily), where a family of fishermen claimed frequent depredation raids by Tursiops truncatus in their nets. Two 254 m long nets named "Sgammerrara" (Sg1, Sg2) and one 1,080 m long Trammel net were used. The Sgammerrara is a fixed monofilament net, divided into three continuous functional sectors: the first two sectors are named respectively "Coda" and "Petto", while the third is named "Campile" and has the same shape as a hook [Fig. 1]. Data comprising species, weight of the catch, as well as damages on the nets (number of holes/tears testifying the dolphin depredation) were collected daily. CPUE and damages were calculated in order to asses differences among the nets. Moreover, the visual monitoring of the Sg1 was performed in order to report dolphins presences, behaviours and photo-ID of the specimens near the nets.



Fig. 1. The Sgammerrara net

Results
11 sampling sessions on Sg1, 11 on Sg2 and 7 in the Trammel net were carried out. In relation to the damages on the nets, it can be assumed that dolphins depredated more the Sg1 (82% of hauls), less with the Sg2 (63% of hauls) and never the Trammel net (ANOVA $p<0.001$). Moreover, the CPUE was the highest for the most damaged gear (Sg1-CPUE=9 ± 2 kgh-1m-1; Sg2-CPUE=1.09 ± 0.07 kgh-1m-1; Trammel net-CPUE=1.04 ± 0.09 kgh-1m-1; ANOVA $p<0.001$) [Fig. 2]. In addition, the composition of the catches was different between Sgammerrara and Trammel net. No by-catch event was registered during the experiments. Three different animals were identified (Foto-ID) twice and the observation indicated that specimens moved towards the Campile and stayed there (in total 3.5 hours) with a feeding behaviour.

Discussion
A careful analysis of the collected data set suggests that the dolphins differently depredated the nets in relation to nets fishing efficiency and to species composition. The behavioural observation allowed to make the hypothesis that dolphins could use the Campile sector of Sgammerrara as a barrier against which they push fish. The experiment confirms the efficiency of Tursiops truncatus strategies as a result of its behavioural performances and its absence of by-catch events. The analysed phenomenon of depredation is an example of Tursiops truncatus high behavioural plasticity and ability to discriminate among different opportunities, choosing those providing greater benefits.

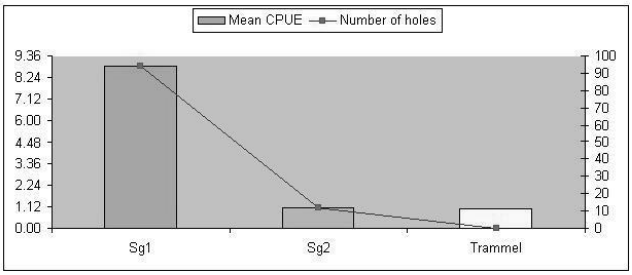


Fig. 2. Mean of CPUE values and of holes number for the three nets

References
1 - Blanco C., Salomon O., Raga J.A., 2001. Diet of the bottlenose dolphin (Tursiops truncatus) in the western Mediterranean Sea. *Journal of the Marine Biology,* Association UK 81, 1053–1058.
2 - Buscaino G., Buffa G., Sarà G., Bellante A., Tonello Junior, A.J., Hardt Sliva F.A., Cremer M.J., Bonanno A., Cuttitta A., Mazzola S., 2008. Pinger affects efficiency and damages of bottom gill nets by bottlenose dolphins. Fisheries Science. Volume 75, Number 3 / May, 2009.

HYDROCARBON DISPERSAL IN THE GULF OF NAPLES: A PARAMETRIC STUDY

B. Buonocore [1], D. Cianelli [2], P. Falco [1]*, R. Guida [1], M. Uttieri [1], G. Zambardino [1] and E. Zambianchi [1]
[1] Department of Environmental Sciences - Parthenope University - pierpaolo.falco@uniparthenope.it
[2] 2 ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale, Via di Casalotti 300, 00166 Roma, Italy

Abstract
Surface current measurements provided by a HF radar system allowed to identify typical patterns of the circulation of the Gulf of Naples (Tyrrhenian Sea), and to associate them with the prevailing forcing conditions. Circulation data were then used as input for a model simulating the transport of particles released in ocean basins (GNOME - General NOAA Oil Modeling Environment). The results of this study highlight peculiar characteristics of the surface dynamics and transport processes in the Gulf of Naples, allowing an estimate of the residence times and the identification of potential particle aggregation and retention areas.
Keywords: Circulation, Tyrrhenian Se, Water Transport, Pollution

Historical reports on the circulation of the Gulf of Naples (GoN) highlight the occurrence of highly dynamic structures over the basin [1, 2]. As for other marginal and coastal basins, even in the GoN wind stress represents the most important local forcing, directly and indirectly affecting surface current fields [1, 2, 3, 4, 5]. Wind forcings display a typical seasonality [5] associated to the large-scale atmospheric circulation acting over the region; when such forcings are weak, as it often is the case in summer, a locally induced breeze regime can act as primary driver of sea surface circulation. The circulation of the GoN can also be remotely driven by the larger-scale circulation of Southern Tyrrhenian Sea [3], with which it is in direct communication. The resulting circulation structures allow the coexistence and mixing of different water masses [6], with characteristics ranging from those typical of oligotrophic environments [6] to that attributable to coastal systems [7]. In addition to its peculiar hydrographic and oceanographic features, the GoN holds a leading role among the marginal basins of Southern Tyrrhenian Sea for socio-economic reasons. A severe anthropic activity impinges on the system, ranging from urban settlements to tourism and maritime traffic, with potentially drastic consequences on ecosystem dynamics and water quality. The necessity of preserving and sustainably exploiting the environmental resources requires an accurate understanding and monitoring of the circulation and transport processes acting in the basin, by which forestalling or mitigating potentially hazardous events. In the last years, increasing awareness about the importance of operational oceanography systems has promoted the development of new techniques and instruments to investigate the real-time, multi-scale circulation patterns in a target area and their effects on transport and diffusion of pollutants, with a special emphasis to coastal zone management. The purpose of this work is to study the surface circulation patterns in the GoN as driven by typical local wind conditions and by Southern Tyrrhenian guidance, and to assess their effects on transport processes of passively buoyant particles. The synoptic, basin scale circulation of the GoN is reconstructed by means of a HF radar system (CODAR O. S. Ltd., USA) operating since October 2004. From the available dataset we selected four periods, each lasting 8 days, with typical forcing conditions for the investigated area. We first analysed the cross-correlation between wind stress and surface current components and directions, and afterwards we investigated the associated surface current velocity and vorticity fields. In addition we applied the GNOME (General NOAA Oil Modeling Environment, NOAA, USA) transport model to simulate the fate of passive conservative particles released in coastal sub-area (Bay of Naples). The results here presented indicate that each set of conditions determines peculiar, not easily foreseen circulation structures and transport processes, as the result of the superimposition of multiple co-occurring factors. Such an integrated approach, moreover, permits an evaluation of the renovation times of the water mass and the investigation of the exchange mechanisms between sub-basin areas.

References
1 - Moretti M., Sansone E., Spezie G., De Maio A., 1977. Alcuni aspetti del Movimento delle acque nel golfo di Napoli. *Annali I.U.N.* 46: 207-2172
2 - De Maio A., Moretti M., Sansone E., Spezie G., Vultaggio M. 1985. Outline of marine currents in the bay of Naples and some considerations on pollutant transport. *Il Nuovo Cimento C* 8 (6): 955-969
3 - Gravili D., Napolitano E. and Pierini S., 2001. Barotropic aspects of the dynamics of the Gulf of Naples (Tyrrhenian Sea). *Cont. Shelf Res.*, 21: 455-471
4 - Grieco L., Tremblay L.-B. and Zambianchi E., 2005. A hybrid approach to transport processes in the Gulf of Naples: an application to phytoplankton and zooplankton population dynamics. *Cont. Shelf Res.*, 25: 711-728
5 - Menna M., Mercatini A., Uttieri M., Buonocore B. and Zambianchi E., 2007. Wintertime transport processes in the Gulf of Naples investigated by HF radar measurements of surface currents. *Nuovo Cimento C*, 6: 605-622
6 - Carrada G. C., Hopkins T. S., G. B., Ianora A., Marino D., Modigh M., Ribera d'Alcala M.,B. S. D. C., 1979. Variability in the hydrographic and biological features of the Gulf of Naples. P.S.Z.N.I: *Marine ecology* 1: 105-120
7 - Ribera d'Alcala M., Modigh M., Moretti M., Saggiomo V., Scardi M., Spezie G., Zingone A., 1989. Una storia infinita: eutrofizzazione nella Baia di Napoli. *Oebalia* XV-1: 491-501

COMPARAISON DES CARACTERISTIQUES ENVIRONNEMENTALES ET DE LA DISTRIBUTION DE LA MATIERE ORGANIQUE DANS DEUX LAGUNES MEDITERRANEENNES : BAGES-SIGEAN ET CANET

R. Buscail [1]*, F. Vouvé [2], D. Aubert [1], M. Desmousseaux [1], C. Canal [2] and G. Jeanty [1]
[1] CEFREM -UMR 5110 CNRS- Université de Perpignan, 66860, France - buscail@univ-perp.fr
[2] IMAGES-EA, Université de Perpignan, 66860, France

Abstract
Les caractéristiques environnementales et la matière organique de l'eau et des sédiments superficiels de deux écosystèmes lagunaires du littoral du Languedoc-Roussillon (Golfe du Lion - Méditerranée NW) ont fait l'objet d'un suivi saisonnier (2009). Ces recherches ont été réalisées dans le cadre du programme ANR-CES et de son action CIEL «Contaminants et Interactions au sein d'Ecosystèmes Lagunaires». Ces résultas seront intégrés à l'interprétation de deux autres tâches, la tâche 2 «Caractéristiques du modèle biologique : *Anguilla anguilla*» et la tâche 3 «Impact des contaminants dans les milieux et les organismes».
Keywords: Lagoons, Sediments, Surface Waters, Organic Matter, Western Mediterranean

Les lagunes de Canet et Bages-Sigean ont été choisies pour leurs contrastes en superficie, profondeur, communication avec la mer et apports en eau douce qui conditionnent leurs caractéristiques environnementales. La plus vaste, Bages-sigean avec une surface de 38 km^2 et un bassin versant 12 fois supérieur, a une profondeur moyenne de 1,5 m et maximale de 3 m. Le chenal portuaire de Port-La Nouvelle assure sa communication avec la mer à son extrémité sud. Elle est alimentée en eau douce par trois cours d'eau (Berre, Robine, Canelou). Canet est plus petite, avec seulement 6 km^2 mais un bassin versant très important (53 fois supérieur). Sa profondeur moyenne de 0,2 m est très réduite (maximum 0,7 m). La lagune de Canet possède un grau quasi fermé par des vannes non-fonctionnelles. Elle est alimentée en eau douce par deux canaux permanents (Agouille de la Mar, Fosseille) et une rivière temporaire (Réart).
Des mesures de T°, pH, salinité, O_2 dissous, réalisées à chaque prélèvement saisonnier d'eau aux 15 stations, renseignent sur la variabilité physico-chimique de la tranche d'eau. Dans les deux lagunes, la température varie entre 5 et 25°C mais les minimums de salinité et d'O_2 dissous peuvent être plus bas à Canet où des épisodes d'eutrophisation sont classiques en été. La quantité de matière organique et la qualité des eaux sont évaluées par les paramètres suivants : MES, COP, NtP, Chl*a*, COD, NtD, sels nutritifs (PO_4^{2-}, NO_3^{2-}, SiO_2). Les carottages des sédiments superficiels ont permis d'observer les variations spatiales et temporelles des caractéristiques de leur contenu en matière organique. Son abondance est décrite par les concentrations en Corg, Nt, lipides, carbohydrates et acides aminés et sa qualité par les rapports C/N, Chl*a*/Pheo et le C-Bioassimilable.
Globalement les eaux de Canet sont 7 fois plus riche en MES (150mg/l contre 20mg/l), enrichies en matière organique (11% contre 4% COP et 1,1 contre 0,6% NtP). La variabilité spatiale est peu marquée dans Canet (excepté un enrichissement au droit de l'Agouille de la Mar), par contre dans Bages on observe une nette distinction entre le bassin Nord enrichi car soumis aux apports des effluents de la ville de Narbonne canalisés par la Robine et le Canelou. Le bassin sud est en communication avec la mer d'où l'effet de dilution par les eaux marines moins riches.
Les sédiments présentent des concentrations en Corg et Nt décroissantes de Canet à Bages N puis Bages S en relation avec une même tendance dans les eaux sus-jacentes. En terme de qualité, la matière organique des sédiments de Canet est nettement enrichie en C-Bioassimilable (6,2 mg/g contre 4,3 mg/g à Bages N et 3,1 mg/g à Bages S) principalement en raison de concentrations en lipides et carbohydrates supérieures lui conférant un caractère nutritionel important (48% du CO total).
Une comparaison sera établie avec une lagune voisine, celle de Salses-Leucate précédemment étudiée [1].

References

1 - Buscail R., Vouvé F., Lecomte-Finiger R., Lenfant P., Pastor J., Abdullah M., CertainR., 2009. Entre terre et mer : la lagune de Salses-Leucate, un "lac marin". In : Monaco A., Ludwig W., Provansal M., Picon B. (eds). Le Golfe du Lion. Un observatoire de l'environnement en Méditerranée. Editions Quae, pp 167-182 (chapitre 11).

MESURHO : A HIGH FREQUENCY OCEANOGRAPHIC BUOY AT THE RHONE RIVER MOUTH

J. F. Cadiou [1]*, M. Repecaud [1], M. Arnaud [2], C. Rabouille [3], P. Raimbaud [4], O. Radakovitch [5], S. Meule [5] and P. Gaufrès [6]
[1] Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), BP 330, 83507 La Seyne sur Mer – France - jfcadiou@ifremer.fr
[2] Institut de Radioprotection et de Sureté Nucléaire (IRSN), BP 330, 83507 La Seyne sur Mer – France
[3] Laboratoire des Sciences du Climat et de l'Environnement (LSCE), Avenue de la Terrasse 91198 Gif-sur-Yvette – France
[4] Centre d'Océanologie de Marseille (COM), 163 avenue de Luminy 13288 MARSEILLE – France
[5] CEREGE, Europôle de l'Arbois 13545 Aix-en-Provence – France
[6] Centre d'Etudes Techniques Maritimes Et Fluviales (CETMEF) 2, Bd Président Kennedy - 13097 Aix-en-Provence – France

Abstract
As the current main source of continental fresh water discharge in the Mediterranean Sea, the Rhone river inputs are a key forcing for ecosystems of the Gulf of Lions in the northern part of the western basin. An oceanographic buoy has been installed at the Rhone river mouth in June 2009 for high frequency multi-parameter measurements with bottom, water column and air sensors. Data are sent in near real time towards an onshore data center.
Keywords: Rhone Delta, Coastal Systems, Gulf Of Lions, Instruments And Techniques, River Input

With an average flow of 1700 $m^3.s^{-1}$, the Rhone river is currently the main source of fresh continental water inputs in the Mediterranean Sea. Draining an industrialized catchment, the Rhone river is therefore a major forcing for the western Mediterranean Sea and the Gulf of Lions ecosystems. Its contribution to riverine inputs in the Gulf of Lions is estimated to be more than 85% for water and 80% for suspended particulate matter (SPM) [1, 2]. Understanding and modeling the functioning of the coastal system in this area requires a good knowledge of the quantity of water, SPM, nutrients and pollutants brought to the sea by the Rhone river.

In order to complete the multi-parameter measurements acquired at the SORA[a] monitoring station located in Arles 50 km upstream from the sea a new instrumented platform was installed at the Rhone river mouth. It will help studying the complex processes occurring in the fresh/saline water transition zone. In the Mediterranean area and especially in the Gulf of Lions, extreme events such as floods and storms are known to play a key role in the ecosystem dynamic. To observe these events, a high frequency observation system has been designed. Coupling high frequency measurement with near real time data transmission will allow detecting an event and triggering additional sampling. It will also provide the mean to periodically check the instrument functioning.

In June 2009, the East Roustan buoy (43° 19.2 N, 4° 52 E, 20 meters water depth) which is one of the two marker buoys of the river prodelta has been replaced by a new platform equipped with oceanographic instrumentation. This new system consists of a buoyancy beacon (fig. 1) which is suitable for small range tide environment [3]. Compared to a chain mooring buoy, this beacon allows simple cable connections between the surface platform and the sea bottom instruments. Bottom sensors get energy from a solar panel unit and are connected to an electronic management and communication device installed in the top part of the buoy.

Initially, the buoy was equipped with two multi-parameter sensors (one below the subsurface and the other close to the sea bottom), a weather station, a photosynthetic active radiation sensor (PAR) and an acoustic current Doppler profiler (ADCP). The acquisition and transmission of periodic data to the Coriolis *in situ* data center (www.coriolis.eu.org) via the GSM network is operational and an interface for online consultation of the data is available. In a second phase, further instruments will be added, including a nutrient sensor, a high resolution altimeter and a benthic station equipped with oxygen microelectrodes for sediment remineralization studies.

This new observation system, Mesurho, is a part of the coastal operational oceanography *in situ* network to be developed in the north western Mediterranean. The collected data will be used among others by the Previmer forecasting and analysis system (www.previmer.org).

Mesurho project has received support from the Ifremer MEDICIS program and the French national research agency (ANR) through the EXTREMA and CHACCRA projects. It has received funding support from the Provence Alpes Côte d'Azur Region.

[a] SORA : Station d'Observation du Rhône à Arles

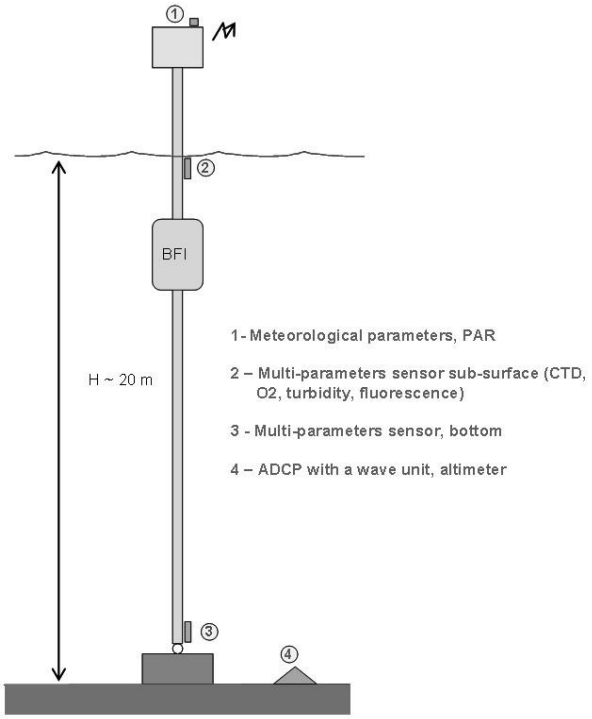


Fig. 1. Mesurho buoy instruments

References

1 - Evaluation des flux polluants à la Méditerranée (hors Rhône) – SIEE 2003 – Agence de l'Eau Rhône Méditerranée & Corse
2 - Durrieu de Madron X., Abassi A., Heussner S., Monaco A, Aloisi J.C., Radakovitch O., Giresse P. Buscail R., Kerhervé P., 2000. "Particulate matter and organic carbon budgets for the Gulf of Lions (NW Mediterranean)." *Oceanologica Acta* vol. 23.
3 - Gaufrès P., Andres B., Dufois F., Interest and limits of oceanographic real time measurement on buoyancy beacon – Case of Rhône delta and gulf of Fos. Mediterranean Days of coastal and port engineering, Palermo 7-9 October 2008.

PALYNOLOGICAL EVIDENCE OF HUMAN IMPACT AND DEFORESTRATION ON WESTERN ROUGH CLICIA, SOUTH COASTAL TURKEY

Hulya Caner [1]*, Nicholas Rauh [2] and Luann Wandsnider [3]
[1] Istanbul University,Ther Institute of marine Sciences and Management - hcaner@istanbul.edu.tr
[2] Department of History, University Hall, Purdue University
[3] University of Nebraska, Department of Anthropology

Abstract
This study was part of the Rough Cilicia Survey Project, which is an ongoing archaeological investigation of a 60 km coastal strip in southern Turkey In this paper palynological examination of surface samples and terrestrial sediments samples indicate a pattern of degraded vegetations from western Rough Cilicia is discussed.. The previous results of palynological samples indicate a pattern of degraded vegetations. *Plantago* is obtained for areas with serious grazing experience; whereas, *Juniperus oxycedrus L.*, *Q.coccifera L.*and *Chenopodiaceae, Plantago* characterize the effect of human impact on natural forests.
Keywords: Biogeography, Eastern Mediterranean, Lagoons

Western Raugh Cilicia lies on the southern Mediterranean coast of modern Turkey and was administrated in Roman times as part of the Roman province of Cilicia (hence the term "Rough ", contrasting with "Flat Cilicia" to the east). The history of human settlement in southwest Turkey has been studied as a series of archaeological and historical field surveys and excavations. For this region, including western Rough Cilicia, the reconstruction of vegetation and human - induced landscape change is primarily based upon pollen analysis and other paleoecological methods. While archaeological data, including those from excavation and field survey, can sometimes be biased by differential site destruction and modern looting of burials, palaeoecological data tend to be continuous and do not suffer from the chance destruction of archaeological remains. During the 2001 and 2002 seasons of the Rough Cilicia Archaeological Survey Project, geophysical trenches were cut in river basins of the Gazipasa countryside in order to obtain pollen and macrobotanical samples to determine the history of regional vegetation patterns. Pollen was concentrated from 0.4 to 1.1 liter subsamples to which exotic Lycopodium spores (c. 12.000 grains per tablet) were added (1).The sediment samples for pollen analysis (~1 cm3 fresh material) were collected as samples and treated using standard palynological techniques ([2], [3]). This method includes HCl, HF, and KOH digestion, before staining with safranine and mounting with glycerine jelly. The pollen percentages are based on the pollen sum of arboreal (AP) and nonarboreal pollen (NAP), excluding spores. The localities of obtained surface samples are represented by three lagoonal areas in the Hacimusa, the Bickici and Delice River basins. Distribution of the pollen grains in Bickici and Delice Rivers differs from that which occurs in the Hacimusa River. Arboreal pollens are represented by Juniperus oxycedrus L. and Pinus in Hacimusa river as the highest value; whereas, *Juglans* reaches the highest values in Bickici and Delice Rivers. According to our preliminary evidence of surface samples, two different vegetation types are in the study area. Eu- Mediterranean vegetation contains xsrophytic shrubs and evergreen vegetation (*Pinus brutia, Quercus and Erica, Artemisia*) and Oro-Mediterranean vegetation includes decidious forest (*Pinus brutia, Q. Cerris, Juniperus, Cedrus*) The previous results of analysis from the terrestrial sediments samples indicate a pattern of degraded vegetations (Figure 1).

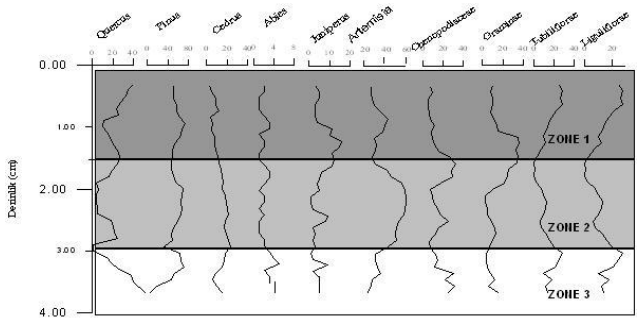


Fig. 1. Relative abundance of dominant pollen types in terrestrial sediments

Plantago is obtained for areas with serious grazing experience; whereas, *Juniperus oxycedrus L., Q. coccifera L.*and Chenopodiaceae, *Plantago* characterize the effect of human impact on natural forests and their replacement by secondary vegetation. They also reveal the existence of three different Palynological zones related to the Last Glacial/Interglacial paleoclimatic conditions in the source area, as reflected by the increasing steppe types.

Tab. 1. Types of vegetation and characteristic assembleges in three lagoonal areas

Lagoonal area	Vegetation type	Characteristic assembleges
Hacimusa river	Oro-Mediterranean	*Pinus brutia, Q.Cerris,Juniperus, Cedrus*
Delice river	Eu-Mediterranen	*Pinus brutia, Quercus* (ever green)*and Erica, Artemisia*
Bickici river	Eu-Mediterranean	*Pinus brutia, Quercus* (ever green) *and Erica, Artemisia*

;

References
1 - Stockmar, J.,1971. Tablets with Spores Used in absolute pollen analysis. Pollen Spores, 13.Pp.615-621.
2 - Erdtman, G.,1954. An introduction to pollen analysis. Chronica Botanica Company, U.S.A..
3 - Moore, P.D., J.A., Webb, J. A., and Collinson, M. E.,1991.Pollen Analysis. Blackwell Scientif Publications, Oxford, Pp.216.

ANTIFOULANTS IN SEDIMENTS FROM THE FRENCH MEDITERRANEAN COAST

Roberto Cassi [1], Imma Tolosa [1] and Jae R. Oh [1]*
[1] IAEA - j.oh@iaea.org

Abstract

Organotins have been used most extensively as the main biocide in antifouling paints. Due to deleterious effects, the use of organotins on small boats has been widely prohibited since the mid-1980s. IMO's Antifouling System Convention entered into force on 17 Sept. 2008 [1]. As a result, other formulations have been used. The goal of this study is to assess the level of antifoulants in ports and marinas along the Southern France coastline. Simultaneous derivatisation and extraction were used for organotins sample preparation and a GC-FPD (610 nm filter) was used for determinations. Other antifoulants were extracted by a microwave and analysed with a GC-NPD. Every port and marina showed high levels of organotins (37-4000 ng Sn/g d.w.) [2]. The only non-organotin compound found was Irgarol 1051 (<1-689 ng/g d.w.).

Keywords: Sediments, Coastal Waters

Organotin compounds have been used most extensively as the main biocide in marine antifouling paints. Organotin-based paints have seen service on boats of all sizes, from small yachts to supertankers, therby ensuring the global dispersion of tributyltin (TBT) throughout the marine environment. Due to deleterious effects on non-target organisms, the use of organotin compounds as antifouling agents on boat hulls of small vessels has been widely prohibited since the mid-1980s. IMO's Antifouling System Convention entered into force on 17 September 2008 [1]. As a result of restrictions on the use of organotin based paints, other antifouling formulations containing organic biocides have been utilised. Ports and marinas are recipients of a variety of toxic chemical inputs and can affect adjacent marine coastal ecosystems by, for example, dumping of dredge spoils. Thus, monitoring levels of contaminants in ports and marinas should be an important issue for local authorities. The goal of the present study is to assess the occurrence of organotin compounds and several other antifoulants in ports and marinas all along the Southern France coastline. Apart from organotin compounds, Irgarol 1051, Sea-nine, chlorothalonil, dichlofluanid and folpet were also measured in surface sediments collected in the major ports and marinas. Simultaneous derivatisation and extraction using sodium tetraethylborate were used for organotins sample preparation. An HP 5890 GC equipped with a FPD (610 nm filter) was used for all organotin determinations. A 30 x 0.25 mm x 0.25 um HP-5 capillary column was used with splitless injection.Other antifoulants were extracted by a microwave system and extracts were cleaned up using SPE florisil cartridges. An HP 6890 GC-NPD was used for all antifoulants determinations. A 30 x 0.25 mm x 0.25 um HP-5 capillary column was used with pulse splitless injection. Every port and marina exhibited high levels of organotin compounds, with concentrations ranging from 37 to 4000 ng Sn g^{-1}dry wt [2]. The only non-organotin compound found was Irgarol 1051. The concentrations ranged from <1 to almost 700 ng g^{-1}dry wt and, not surprisingly, the highest levels were found near the ship chandlers. Despite the strict regulations introduced 20 years ago in France banning the application of TBT based antifouling paints on ships of <25 m and more recently on all other boats, TBT still appears to be the main active ingredient in marine antifouling currently used in Southern France.

References

1 - IMO Press Briefing 40, 16 September 2008, Harmful ships' paint systems outlawed as international convention enters into force.

2 - Cassi R., Tolosa I. and de Mora S., 2008. A survey of antifoulants in sediments from Ports and Marinas along the French Mediterranean coast. Marine Pollution Bulletin, 56: 943–1948 (scientific article).

COMPARAISON DU CYCLE SEXUEL DE *MONODONTA ARTICULATA* EN MILIEU D'ORIGINE (ILES KERKENNAH) ET APRES TRANSFERT SUR SITE POLLUE

Mohamed Karim Cheour [1] and Nejla Aloui Bejaoui [1]*
[1] Institut National Agronomique de Tunisie, 1082, Tunisie - bejaoui.nejla@inat.agrinet.tn

Abstract
L'activité sexuelle de *Monodonta articulata* a été étudiée dans deux sites du Golfe de Gabès (Tunisie) dont l'un est fortement soumis aux rejets anthropiques. Durant la période d'échantillonnage, le même schéma général de déroulement des stades du développement gonadique est observé avec un repos sexuel hivernal (janvier - février) et une activité de reproduction (mars à juin) avec une petite variation selon le sexe. Le décalage, mis en évidence au niveau de la durée des différentes phases sexuelles entre les mâles et les femelles des deux sites, pourrait, à terme, avoir des conséquences sur le potentiel reproducteur de l'espèce.
Keywords: Mollusca, Gastropods, Reproduction, Gulf Of Gabes

Introduction
Monodonta articulata est un mollusque prosobranche (Archeaogasteropode; Trochidae) très commun en Méditerranée. Cette étude porte sur la caractérisation des stades sexuels de *Monodonta articulata* dans son milieu d'origine (îles Kerkennah) et après transplantation dans un site pollué (port de Sfax). Cela nous permet d'évaluer l'influence des polluants sur le potentiel reproducteur de l'espèce.

Matériel et méthodes
L'étude a été réalisée durant la période allant de janvier à juin 2009. Un effectif total de 360 individus de *M. articulata* a été prélevé du site de référence (îles Kerkennah) et transféré en cages dans le port de Sfax. Une trentaine d'individus ont été récoltés mensuellement dans chaque site. Les observations macroscopiques ont été classées selon l'échelle de maturité d'Underwood [4] modifiée avec une précision complémentaire relative aux évolutions cytologiques. L'étude macroscopique a été complétée par une étude histologique des gonades en microscopie photonique.

Résultats et discussions
Dans le site de référence (îles Kerkennah)**,** le repos sexuel **(Stade I)** s'étend, chez les deux sexes, sur les mois de janvier et février (Fig.1).

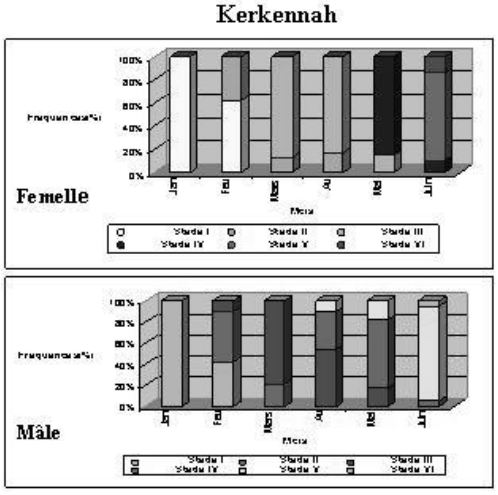


Fig. 1. Déroulement de la gamétogénèse chez les *M.articulata* (femelles et mâles) du site Kerkennah de janvier à juin 2009

Le début de la gamétogenèse **(Stade II)** chez les deux sexes commence dès février et s'achève en avril (femelles) et en mars (mâles)**.** Le stade de développement des gamètes **(Stade III)** est précoce chez les mâles. La maturité sexuelle **(Stade IV)** est de même plus précoce dans la lignée mâle ; cette maturité étant atteinte un mois plus tôt que chez les femelles. L'émission gamétique **(Stade V et VI)** s'étend d'avril à juin chez les mâles et de mai à juin chez les femelles**.** *M. articulata* transférée dans le port de Sfax montre des variations dans la durée et la séquence des différentes phases sexuelles. On observe une prolongation de la période du repos sexuel chez les deux sexes et une précocité de la maturité sexuelle des gamètes femelles et mâles (Fig.2). Toutefois un prolongement du stade de développement est enregistré chez les mâles et les femelles du site Kerkennah.

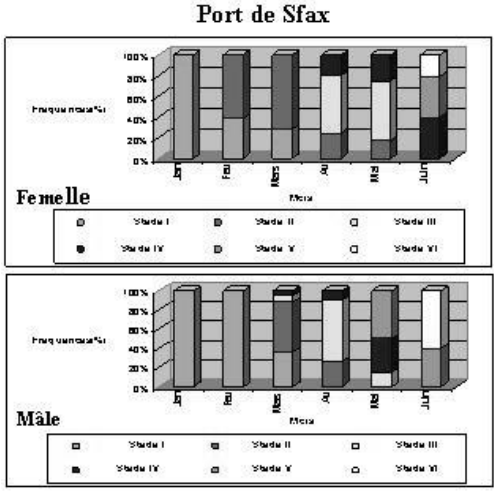


Fig. 2. Déroulement de la gamétogénèse chez les *M.articulata* (femelles et mâles) du site port de Sfax de janvier à juin 2009

Une comparaison du déroulement du cycle reproducteur entre les *M. articulata* des deux sexes d'un même site montre une absence de synchronisation entre les périodes de ponte des gamètes mâles et femelles, et cela aussi bien à Kerkennah qu'à Sfax. L'étude de l'activité sexuelle de *M.articulata* des sites, Kerkennah et port de Sfax, a montré en définitive que la gamétogenèse se déroule de mars à juin (avec une petite variation selon le sexe). Ces résultats concordent avec ceux de Garwood et Kendall [3] et Underwood [4]. L'inactivité sexuelle, observée en hiver (janvier- février), a été également mise en évidence par Underwood [4] et Williams [5].

Conclusion
Le décalage observé au niveau de la durée des différentes phases sexuelles entre les mâles et femelles des deux sites se traduit par des perturbations au niveau de la séquence des phénomènes sexuels. Cette étude doit être complétée par une analyse plus complète de la nature des polluants incriminés et par l'identification de leur effet au niveau cytologique.

References
1 - Keiji I., 2000. Life cycle and habitat shift of the Trochid snail *Diloma suavis* within intertidal mussel zones. *Journal of molluscan studies*, 66: 9 -20.
2 - Lasiak T., 1987. The reproductive cycle of three Trochid gastropods from the Transkei coast, Southern Africa. *Journal of molluscan studies*, 53: 24 -32.
3 - Garwood P.R. and Kendall M.A., 1985.The reproductive cycles of *Monodonta lineata* and *Gibbula umbilicalis* on the coast of Mid Wales**.** *J.mar.boil.Ass.U.K.*, 65:993 -1008.
4 - Underwood A. J., 1972. Observations on the reproductive cycles of *Monodonta lineate*, *Gibbula umbilicalis* and *G. cineraria*. *Marine biology*, 17: 333-340.
5 - Williams E. E., 1965. The growth and distribution of *Monodonta lineata* (da Costa) on a rocky shore in Wales**.** *Fld. Stud*., 2: 189 -198.

IMPACT DU PROJET D'AMENAGEMENT DE LA VALLEE DU BOU REGREG SUR LA QUALITE DES EAUX DE BAIGNADE DE LA PLAGE DE SALE

Essediya Cherkaoui [1]* and Aderrahman Nounah [1]

[1] Laboratoire : Enegétique, Matériaux et Environnement (Ecole supérieure de Technologie Salé) - echerkaoui@yahoo.fr

Abstract

La plage de Salé fait partie de la zone atlantique du nord, et s'étend sur 1 500 m. Ces dernières années, cette plage a été classée non-conforme à la baignade. Cela est dû essentiellement, à la pression des estivants et au fait que les eaux de la ville sont rejetées directement, sans traitement, le long de la côte ou au niveau de l'oued Bou Regreg.

Keywords: Sewage Pollution, Coastal Waters

Introduction

Le long de la côte marocaine, parmi les 170 plages identifiées comme des espaces de loisirs, seules 86 plages font l'objet d'une surveillance de la qualité de leur environnement. Ce travail consiste à évaluer la qualité actuelle des eaux de baignade de la plage de Salé, après la réalisation d'une grande partie des travaux du projet de dépollution de l'oued et du littoral. Ce projet s'inscrit dans le cadre du projet d'aménagement de la Vallée du Bouregreg.

Qualité des eaux de baignade de la plage de Salé

Salé est une ville côtière marocaine située sur la rive droite de l'Oued Bouregreg. Elle s'étend sur une superficie de 672 Km^2 et a une population d'environ 823 345 habitants [1]. La totalité des effluents d'eaux usées de la ville de Salé sont rejetés directement dans l'océan Atlantique et dans l'oued Bouregreg, sans prétraitement. Cela provoque la contamination de la plage par les eaux de l'oued polluées à basse mer, et par la remontée des eaux côtières trop chargées par les rejets existants à haute mer.

Pour participer à l'amélioration de la qualité des eaux de baignade de la plage de salé ainsi que celles de l'oued Bouregreg et de remédier aux problèmes de pollution, le projet de dépollution de la côte atlantique et l'Oued Bouregreg a été initié (dans le cadre de l'aménagement de l'ensemble de la vallée du Bou Regreg). Ce projet prévoit la construction de stations d'épuration des eaux usées avant leur rejet dans l'Atlantique, minimisant ainsi leur impact. Afin de caractériser la qualité des eaux de la plage de Salé, après trois années de travaux pour le projet de dépollution, nous avons utilisé des indicateurs de la pollution fécale : les coliformes fécaux (CF) et les streptocoques fécaux (SF) durant les deux marées, en 2009. L'eau a été prélevée dans trois stations (1, 2, 3) le long de la plage lors de chaque marée. Dans toutes les stations échantillonnées à basse mer et à haute mer, la concentration moyenne des indicateurs de pollution fécale (CF= 2,03 10^8 ; 0,3 10^8/100ml et SF= 10^8 & 6,95 10^5/100ml) dépassent de loin les valeurs minimales. L'eau de la plage de Salé est donc une plage de mauvaise qualité, de classe D, non conforme à la baignade [2]. La concentration des coliformes fécaux reste toujours supérieure à celui des streptocoques fécaux lors des deux marées. Le rapport des coliformes fécaux sur les streptocoques fécaux (CF/SF) est supérieur ou égal à 1, indiquant que la pollution fécale au niveau de la plage est d'origine humaine. Cela est justifié puisque la source de la pollution est presque totalement due aux déversements des rejets urbains de la ville de Salé, sans traitement préalable, le long de la côte ou bien dans l'oued Bouregreg.

Conclusion

Le resultat des analyses bactériologiques classe les eaux de la plage de salé non-conformes à la baignade. Cela rejoint, le résultat du rapport nationale de la surveillance de la qualité des eaux de baignade au Maroc, quiconsidérait la plage de Salé comme étant une plage non conforme à la baignade durant les 10 dernières années. Cependant, l'impact positif du projet de dépollution de l'Oued et de la côte atlantique -dans le cadre de l'aménagement de la vallée du Bouregreg - qui a permis la supression de quelques rejets (infrastructures, installations…) existant sur les berges de l'Oued, n'a pas encore été observé.

References

1 - Anonyme 2004 : Rapport du ministère de statistique

2 - Anonyme 2008 : Rapport national de surveillance de la qualité des eaux de baignade 2007/2008

HYPOTHESES ON A MEDITERRANEAN SEA REGIME SHIFT IN THE LATE 1980S

A. Conversi [1]*, S. Fonda-Umani [2], T. Peluso [3], J. Molinero [4] and A. Santojanni [3]
[1] CNR - ISMAR and University of Plymouth - a.conversi@ismar.cnr.it
[2] University of Trieste, Dept. of Life Sciences
[3] CNR - ISMAR
[4] Leibniz Institute of Marine Sciences

Abstract

A comparative study of biological and physical time series in the eastern and western Mediterranean Sea for the period 1960s to 2005, combined with a literature review, finds that all point out to an abrupt period of change in the late 1980s that involved circulation and pelagic systems. We show, using regime shift detection methods, evidence that the Mediterranean Sea underwent a climate shift in the late 1980s. An extension of this analysis to larger scale climate indexes (NHT and NAO), shows that they changed around that time. We hence hypothesize that the Mediterranean shift is part of a larger, hemispheric change, and is related to other shifts recorded during the same period in all other European seas.

Keywords: Global Change, Ligurian Sea, Adriatic Sea, Time Series, Zooplankton

Introduction

Abrupt shifts involving both the physical and the ecological systems, called regime shifts [1,2] have been the focus of recent attention. Marine regime shifts hold particular relevance, because they encompass a multitude of physical properties and ecosystem variables, and subsequently can have major impacts on all trophic levels of marine food webs and the associated biogeochemical cycles. Our initial work in the Gulf of Trieste, North Adriatic, eastern Mediterranean, identified two periods, based on winter SST patterns: 1970-1987 and 1988-2005 [3]. Our analyses of the 36-year copepod abundance time series in the Gulf of Trieste, showed that the second period was characterized by ecosystem-wide changes: the arrival of new species, the rise or decline of several taxa, and changes in the phenology in several species [3]. In this work we extend these analyses to the western Mediterranean, including biological and physical properties over different geographical scales, as well as climate indices, and find that all point out to a period of change in the late 1980s.

Methods

In this study we have utilized the following monthly times series over the 36 year period January 1970 – December 2005, unless otherwise stated: total copepod abundance Gulf of Trieste, Adriatic, Eastern Mediterranean; northern Adriatic mucilage events time series (episodes); northern Adriatic red tides time series (episodes); Adriatic anchovy stock biomass (yearly, 1976-2001); zooplankton abundance, Point B, Ligurian Sea, West Mediterranean (weekly, November 1966 - December 1993); SST, Gulf of Trieste; SLP, Gulf of Trieste; SST, Ligurian Sea; SLP, Ligurian Sea; SST, Mediterranean Sea; SLP, Mediterranean Sea; North Hemisphere Temperature (NHT) index; North Atlantic Oscillation (NAO) index. These data have been analyzed using two regime shift methods: the cumulative sums, and the sequential t-test analysis of regime shifts (STARS). The cumulative sum technique consists of plotting the cumulative sum of standardized values over time, to which is subtracted the mean of time series [4]. The STARS method calculates a Regime Shift Index (RSI), which represents a cumulative sum of normalized anomalies relative to a critical value and provides a probability level for the identified year of regime shift, based on the Student's t-test [7].

Results

All Adriatic biological series investigated in this work (copepods, anchovy biomass, and the mucilage-red tide alternance) over 36 years show a step-like period of change in the late 1980s. The 27 year mesozooplankton series in Villefranche Bay, western Mediterranean, shows a step-like change in the late 1980s as well. To support the hypothesis that these changes in the pelagic system are accompanied by changes in the physical environment, we analyse available hydrographic properties (SST e SLP) at different geographical scales: local/regional (northern Adriatic and NW Mediterranean), and basin (Mediterranean), and compare with climate indices (NHT, NAO - hemispheric scale). We find that they all show a main period of change in the late 1980s Although the time serie are on the order of a few decades, and thus a persistent state cannot yet be assessed with certainty, it is the synchronicity of the period of change, involving biological and physical properties, different trophic levels in both Mediterranean sub-basins, which indicates the presence of a major reorganization in this sea.

Conclusions

Our results suggest that the Mediterranean Sea underwent a major change at the end of the 1980s that encompassed atmospheric, hydrological, and ecological systems, for which it can be considered a regime shift. We provide evidence that links local, regional, and basin scale hydrological properties with two major indicators of large scale climate, the North Atlantic Oscillation index and the North Hemisphere Temperature index, suggesting that the Mediterranean shift is part of a larger scale change in the northern hemisphere. We hypothesize that the shifts that affected the North, Baltic [5], Black [6], and Mediterranean (this work) seas at the end of the 1980s, so far only partly associated, are all linked as part of a northern hemisphere change.

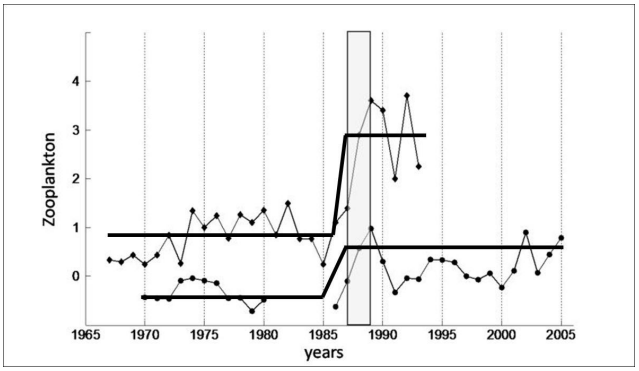


Fig. 1. Interannual variability of zooplankton abundance off Villefranche, Ligurian Sea (diamonds), and of total copepod abundance in the Gulf of Trieste, Adriatic Sea (circles), standard units. The black horizontal lines represent the stepwise trend showing the regime shift in the mean detected by STARS method. T-test, cumulative sums, and the STARS methods, all identift a period of change circa year 1987 (vertical bar).

References

1 - DeYoung B, Barange M, Beaugrand G, Harris R, Perry RI, et al., 2008. Regime shifts in marine ecosystems: detection, prediction and management. *Trends Ecol Evol* 23: 402-409.

2 - Scheffer M, Carpenter SR., 2003. Catastrophic regime shifts in ecosystems: linking theory to observation. *Trends Ecol Evo* 18: 648- 656.

3 - Conversi, A, Peluso T, Fonda-Umani S., 2009. Gulf of Trieste: A changing ecosystem. *J Geophys Res* 114 C03S90 doi:10.1029/2008JC004763.

4 - Rodionov SN, Overland JE., 2005. Application of a sequential regime shift detection method to the Bering Sea. ICES *J Mar Sci* 62: 328–332.

5 - Alheit J, Möllmann C, Dutz J, Kornilovs G, Loewe P, et al., 2005. Synchronous ecological regime shifts in the central Baltic and the North Sea in the late 1980s. ICES *J mar Sci* 62: 1205-1215.

6 - Daskalov GM, Grishin AN, Rodionov S, Mihneva V., 2007. Trophic cascades triggered by overfishing reveal possible mechanisms of ecosystem regime shifts. Proceedings of the National Academy of Sciences 104: 10518–10523.

7 - Rodionov SN, Overland JE (2005) Application of a sequential regime shift detection method to the Bering Sea. ICES J Mar Sci 62: 328–332.

FISHERY DATA AND CLIMATE CHANGE: EVIDENCE OF A RELATIONSHIP FROM THE VENICE LAGOON?

Elisa Coraci [1], Piero Franzoi [1], Matteo Zucchetta [1] and Fabio Pranovi [1]*
[1] Department of Environmental Sciences, University Ca' Foscari, Venice, 30122, Italy - fpranovi@unive.it

Abstract
By analysing regime shifts detected within landings time series from the Venice lagoon, a significant decrease of catches from the mid 80s was highlighted. In order to explore possible causes, the correlation with climatic parameters has been analysed. Results show a significant negative correlation between temperature anomalies and landings, but no correlations with the NAO time series have been found.
Keywords: Fisheries, Temperature, Time Series, Lagoons, Adriatic Sea

Introduction
Trends in annual mean temperature anomalies for the globe show relatively stable temperatures from the 1800 through about 1910, a rapid and steady warming through the early 1940s, followed by another period of relatively stable temperatures through the mid-1970s. A rapid rise similar to that in the earlier part of the century has been observed since [1]. The Lagoon of Venice, like most lagoons, is a sensitive and fragile ecosystem, liable to major and sudden variations and, consequently, very dynamic [2]. Furthemore the lagoon is subjected to different kinds of external pressures and has evolved under strong anthropogenic presence. This emphasizes the challenge of a dynamic management taking into account the ecosystem historical trend. In the context of the environmental management and analysis of possible effects of climate change, growing interest is devoted to time series analysis, since they allow to describe temporal trends and individuate possible points of shift. In this context, landing data could play a crucial role, since it is generally assumed a correspondence between relative abundance of a species in landings and in the ecosystem [3] and often they represent the only available historical data source about temporal variations of the system.

Material and methods
The time series (1945-2008) here presented were obtained from the Chioggia fish market. In order to minimize possible sources of bias, such as variation in the fishing effort and/or fishing grounds, changes in fishing gears and/or target species [4], we decided to use the total catch of commercial categories caught within the lagoon environment by fyke nets (eel, grass goby, shrimp, green crabs, brown shrimp, mullet, sand gobies, flounder, cuttlefish, sand smelt). To detect regime shifts within the time series, the STAR method, which analyses discontinuity or change points expressed by shifts in the variance and especially in the mean [5], has been applied.

Results and discussion
Of the six different phases (regimes) identified, most of them are in agreement with results reported by other authors [6]: 45-64 increasing of the fishing capacity due to the engine-powered boat introduction; 65-75 increase of the carring capacity due to nutrient enrichment (eutrophication); 76-83 decrease in landings due acute eutrophication and beginning of dystrophic crises; 95-08 decrease in landings due to mechanical clam harvesting (Fig.1).

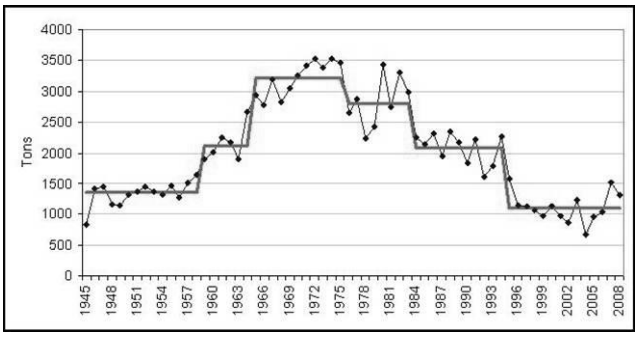


Fig. 1. Regime shifts recorded within the time series of total catches from the Venice lagoon.

We focused mainly on the negative trend recorded between the period 1984-94. To explore possible causes of this phase, we attempted to correlate the landings trend with climatic parameters (temperature and North Atlantic Oscillation-NAO). Results highlight a significant negative correlation between temperature and landings anomalies (cross-correlation analysis), but no correlations with the NAO time series were detected. From 1962-1982 the temperature anomalies are mainly negative, while since 1983 a transitional phase characterized by positive values has been started, specially from 1988. This trend lasted until 2008, showing a general warming that seems to have affected the landings. Climate change, via its oceanographic influence, can play an important role in Adriatic ecosystems due to the incoming Mediterranean warmer water leading to changes of nektonic communities [7]. The obtained results are probably not sufficiently robust to explain the entire time series, being impossible, at the moment, to disentangle the single contribution of all other drivers (such as environmental factors or anthropogenic pressures). It is quite interesting, however, to underpin the inversion (from positive to negative for landings and from negative to positive for temperature) recorded in 1983-1984 (Fig. 2).

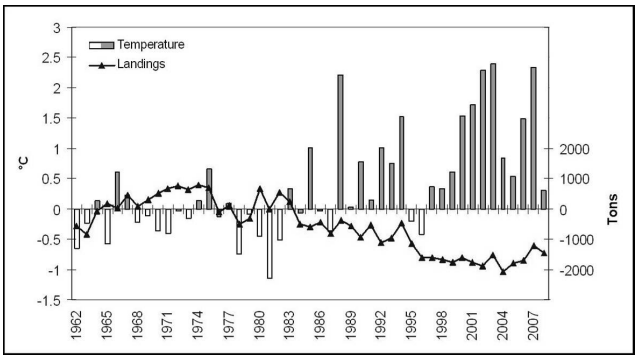


Fig. 2. Time series (1962-2008) of landings (line) and temperature anomalies (box).

References
1 - Jones P.D., Parker D.E., Osborn T.J. and Briffa K.R., 2008. Global and hemispheric temperature anomalies-land and marine instrumental records. *In*: Trends: A compendium of Data on Global Change. Carbon Dioxide Information Analysis Cnter, Oak Ridge National Laboratory, U.S. Dept. of Energy, Oak Ridge, Tenn, U.S.A.

2 - Ravera O., 2000. The Lagoon of Venice: the result of both natural factors and human influence. *Journal of Limnology* 59, 1: 19-30.

3 - Pinnegard J. K., Polunin N.V. and Badalamenti F.,2003. Long-term changes in the trophic level of western Mediterranean fishery and aquaculture landings., *Canadian Journal of Fisheries and Aquatic Sciences*, 60, 222-235.

4 - Caddy J.F., Csirke J., Garcia S.M. and Grainger R.J.R., 1998. How pervasive is "Fishing down marine food webs"?, *Science* **282**, 1383a.

5 - Rodionov S. and Overland J.E., 2005.Application Of A Sequential Regime Shift Detection Method To The Bering Sea Ecosystem, *Ices Journal Of Marine Science*, 62, 328-332.

6 - Libralato S., Pranovi F., Raicevich S., Da Ponte F., Giovanardi O., Pastres R., Torricelli P. and Mainardi D., 2004. Ecological stages of the Venice Lagoon analysed using landing time series data. *Journal of Marine System*, 51, 331-344.

7 - Dulcic J. and Grbec B., 2000. Climate change and Adriatic ichthyofauna. *Fisheries Oceanography*, 9:2, 187-191.

ANATOMY OF RECENT FLOOD DEPOSITS IN THE NEARFIELD OF THE PO PRODELTA (NORTHERN ADRIATIC SEA ITALY)

A. Correggiari [1]*, T. Tesi [1], L. Langone [1], S. Miserocchi [1], A. Asioli [2], A. Gallerani [1], L. Vigliotti [1] and R. A. Wheatcroft [3]
[1] ISMAR CNR Bologna - anna.correggiari@bo.ismar.cnr.it
[2] IGG-CNR, Padova, Italy
[3] COAS Oregon State University Corvallis, OR 97331-5503

Abstract
Comparison between stacked flood-event deposits and discharge records represent a new method for interpreting delta stratigraphy and link the delta to active processes. This work demonstrates the potential of prodelta cores to complement and extend the record back in time from gauge stations.
Keywords: Adriatic Sea, Po Delta, Sedimentation

The Modern Age Po Delta is the result of a marked phase of river-dominated growth, where increased sediment flux derived from climatic change and by human impact both on the catchment (deforestation) and on the delta (diversions to the south accompanied by construction of artificial levees to maintain a fixed channel network) [1]. The modern Po delta has an area of 380 km^2 created during the last 500 years [1]. The present Po River has an annual discharge of 1489 m^3/s as measured from 1918 to 2009 at Pontelagoscuro, 90 km from the coast and just before the apex of the delta. Annual floods occasionally reach 10,000 m^3/s. The Po River has two flood periods, June (snow melt) and November (cold frontal rain). Downstream of Pontelagoscuro, the Po forms a delta consisting of five major distributaries: Maestra, Pila, Tolle, Gnocca and Goro. Average suspended sediment delivery is 11.5 MT yr^{-1}, with a range of 2.9 M/yr (1983) to 22.4 M/yr (1937). Bedload is not measured but is predicted to contribute $\approx$2.5% of the total sediment output of the Po River [2]. Two basic types of prodelta deposits occur in high-resolution seismic records: (i) shingled lobes characterized by laterally continuous seismic reflectors consistent with preserved flood layers and (ii) prodelta lobes accompanied by massive cut-and-fill features. The latter may represent past periods dominated by direct hyperpycnal discharge from the river, whereas the former appears more consistent with present-day transport processes, including perhaps wave-supported gravity flows [1]. The October 2000 flood was a 50-year return interval flood resulting in a thick flood deposit (up to 35 cm) close to Pila mouth of the Po River [3].

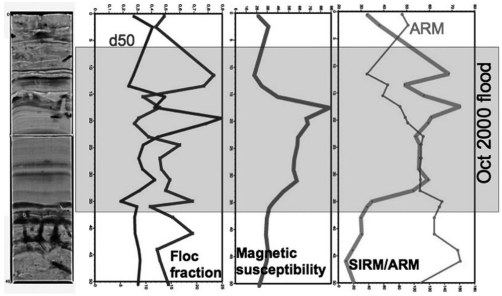


Fig. 1. October 2000 flood deposit recovered at 20m water depth off " Pila" distributary channel. The 35 cm thick flood deposit, observed in Xray image, shows a complex internal stratigraphy also recorded by physical parameters.

Event-response coring on the Po River prodelta coupled with shipboard digital X-radiography, resistivity profiling, and grain-size analyses permitted documentation of the initial distribution and physical properties of the 4 major flood deposits of the last 100 years. From 1994 to 2009 the delta front of the Po river has been sampled and 4 major flood events are recorded in the uppermost unit of the recent deposits occurred in November 1994, October 2000, December 2002 and May 2009. Fine-grained sediment from the Po River settles close to the mouth, leaving only a small amount of material in suspension in the plume for direct deposition onto the prodelta. The Po flood deposit has a complex internal stratigraphy, with multiple layers, laminations, ripple cross bedding, lenticular bedding, soft-sediment deformation structures, and dramatic changes in grain size that imply rapid deposition and fluctuations in energy during emplacement due to ocean weather conditions.
Using the Fall-2000 flood "anatomy" as an example, we demonstrate that it is possible to correlate the associations of benthic foraminifera, thecamoebians, organic carbon content, concentration (X, ARM, SIRM) and grain-size (SIRM/ARM, SIRM X, ARM/X) related magnetic parameters, in prodelta environments to evaluate the discrete unit produced by each flood [4]. In addition a suite a major, minor, and trace elements has been performed on a split core using X-ray fluorescence (XRF) core scanner to provide the variability of bulk-sediment chemistry in each flood deposit. Furthermore the 2009 cores record the 2000 flood layers with the
internal stratigraphy preserved.

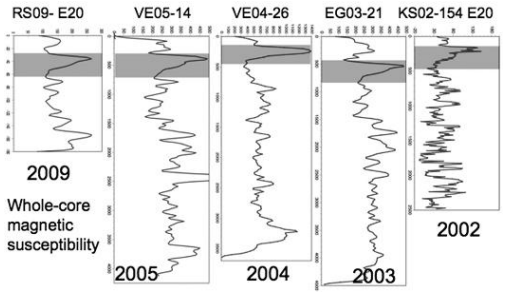


Fig. 2. Magnetic susceptibility record in 5 cores collected, from 2002 to 2009, off *"Po della Pila"* distributary channel. The flood deposit, marked by a shaded area , is preserved after 9 years from the emplacement.

All together these parameters allow to reconstruct the impact of recent and ancient flood events even where sedimentary structures are not unequivocal. An increasing contribution of magnetic minerals with larger grain-size is correlate with minima in the flocculation observed in the sediments.
The recognition of sedimentary structures and textures is important for gaining an inproved understanding of the behaviour and mechanism of sediment deposition from catastrophic flood events. These observations provide insight into nature of large scale flood processes that cannot be measured directly. Moreover a correlation between flood deposit and sediment discharge could define a threshold discharge required to produce sedimentary deposits. To fully appreciate the natural behaviour of shallow-water depositional systems before and under major human impacts, it is necessary to extrapolate time-averaged estimates of changes in sediment supply from indirect data, such as the volume of depositional units (delta lobes) measured from HR seismic profiles [5].

References
1 - Correggiari, A. Cattaneo and F. Trincardi., 2005. The modern Po delta system: lobe switching and asymmetric prodelta growth, *Mar Geol* 222–223 49–74.
2 - Syvitski J. P.M., Kettner A.J., Correggiari A. and Nelson B.W., 2005. Distributary channels and their impact on sediment dispersal, *Mar Geol* 222–223 75–94.
3 - Nittrouer C.A., Miserocchi S., Trincardi F., 2004. Investigation of Po and Apennine Sediment Transport and Accumulation. *Oceanog., 17*, 46-57.
4 - Tesi T., Miserocchi S., Goñi M.A. and Langone L., 2007 Source, transport and fate of terrestrial organic carbon on the western Mediterranean Sea, Gulf of Lions *Mar. Chem.* 105 101–117.
5 - Trincardi F., Cattaneo A., Correggiari A., 2004 Mediterranean prodelta systems: natural evolution and human impact *Oceanog.* 17, 34-45.

MARINE ACIDIFICATION EFFECTS ON REPRODUCTION AND GROWTH RATES OF CORALLINACEAE SPORES (RHODOPHYTA).

Francesco Cumani [1]*, Fulvia Bradassi [1], Annarita Di Pascoli [1] and Guido Bressan [1]
[1] University of Trieste, Dept Life of Sciences - francescocumani@libero.it

Abstract
A study on the effect of marine acidification on the production and surface increase of Corallinales spores was realized in an artificial controlled culture. The increase of CO_2 concentration in the artificial culture inhibited Corallinaceae spore production and growth, and caused an increase in the mortality of germination disks.
Keywords: Global Change, Algae, Adriatic Sea

During the last few years the effect of the increase of carbon dioxide has been studied on mature calcareous red algae [1], [2], [3]. But little is known on the effect of marine acidification on the reproduction rates and surface increase of the Corallinaceae. For this reason a study on the production and growth of Corallinales spores was realized in an artificial controlled culture (microcosm). The values of pH, salinity, temperature and Total Alkalinity of the seawater were recorded several time every day at random intervals.
The calcareous red algae were submitted to different concentrations of carbon dioxide in three different bathtubs (15 l each). We carried out three "monophase cultures" (May and October 2008, May 2009) during which the values of pCO_2 and of pH (first "control" bathtub pCO_2 = 370 ppm and pH = 8,2; second "intermediate" bathtub pCO_2 = 550 ppm and pH = 8,0; third "acid" bathtub pCO_2 = 760 ppm and pH = 7,8) [4], were maintained constant in each bathtub during the entire period of insemination; we made a "triphase culture" (July 2008) during which the pCO_2 was progressively fitted step by step in three phases from 370 to 760 ppm in third bathtub and fitted step by step in two phases from 370 to 550 ppm in second bathtub. The calcareous encrusting red alga *Lithophyllum incrustans* Philippi (Corallinaceae) was sampled in the gulf of Trieste (north Adriatic, Mediterranean Sea) to a depth of 3-4 m. The samples were subjected to thermic shock (temperature of about 24°C), to induce better sporulation (production and morphogenetic development of the spores). The spores were grown on specific supports slides for evaluation under the microscopy. A census of the growth disks was carried out within the first week from the beginning of the insemination, under the optic microscope. Subsequently some selected thalli were marked randomly and photographed weekly to study the surface growth rates (Image Pro Plus 6.0) [5].

In "monophase culture", even if developed in different seasons, a decrease in the presence of the thalli was observed as the CO_2 concentration increased. In the July culture ("triphase culture" – progressive acidification), October 2008 and May 2009 ("monophase culture" – pCO_2 and pH constant) after one month from the beginning of the culture a new census of the thalli was carried out. In all three cases an increase in the mortality of thalli was recorded with pCO_2 increase (Fig. 1).

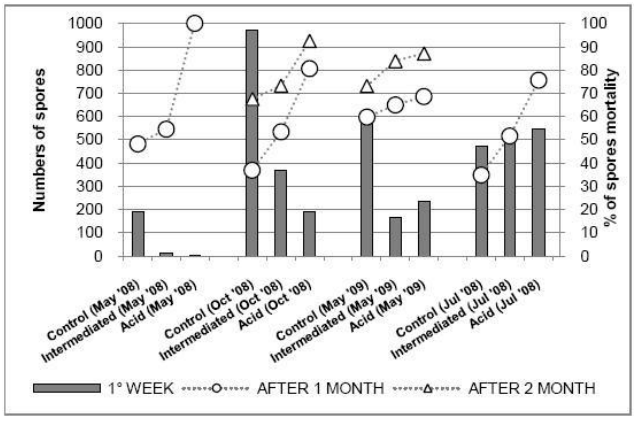


Fig. 1. Number (bars) and % mortality of coralline algae spores (circles and triangles) in "monophase" (May and Oct '08, May '09) and "triphase" (Jul '08) cultures

The rate of growth of the germinated disks was expressed as the difference between the surface of the thalli on their last day of culture and their measured surface after a week from the beginning of the insemination (ΔS). In "monophase culture" the thalli show a smaller growth with an increase of seawater acidity (Fig. 2).

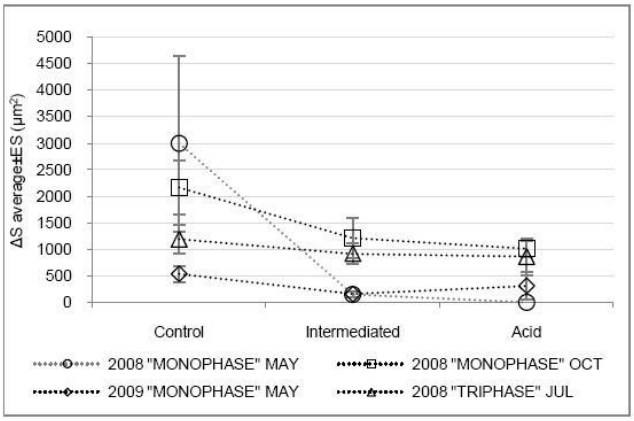


Fig. 2. Average spores growth (ΔS average) after 1 month in "monophase" and "triphase" culture

The results indicate that the increase of CO_2 concentration in the artificial culture inhibits the Corallinaceae spore production and growth, and an increase of the mortality of germination disks. This could have a negative influence on the colonization of calcareous algae not only at the species level, but at an ecosystem level since other authors have reported similar results [1], [2].

References
1 - Hall-Spencer J., Rodolfo-Metalpa R., Martin S., Ransome E., Fine M.,Turner S.M., Rowley S. J., Tedesco D. and Buia M.C., 2008. Volcanic carbon dioxide vents show ecosystem effects of ocean acidification. *Nature*, 454: 96-99.
2 - Kuffner I. B., Andersson A. J., Jokiel P. L., Rodgers K. S. And Mackenzie F. T., 2008. Decreased abundance of crustose coralline algae due to ocean acidification. *Nature Geosci*, 1. 114–117.
3 - Langdon, C. *et al.*, 2002. Review of experimental evidence for effects of CO_2 on calcification of reef builders. *Proc. 9th Int. Coral Reef Sym.*, 2: 1091-1098.
4 - Parry M., Canziani O., Palutikof J., van der Linden P., Hanson C., 2007. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). *Cambridge University Press*.
5 - Cumani F., Di Pascoli A., Bressan G., 2008. Phenotypic observations of bioindicators in laboratori culture: *Pneophyllum fragile* Kützing and *Hydrolithon boreale* (Foslie) Chamberlain (Corallinales, Rhodophyta). *Biol. Mar. Mediterr.*, 15 (1): 260-261.

THE ROMANIAN BLACK SEA MACROALGAE UNDER CURRENT ENVIRONMENTAL QUALITY OF COASTAL WATERS

Sava Daciana [1]* and Bologa s Alexandru [2]
[1] Faculty of Natural and Agricultural Sciences, "Ovidius" University - daciana.sava@gmail.com
[2] 2National Institute for Marine Research & Development "Grigore Antipa", Mamaia 300, RO-900581, Constanta 3, Romania

Abstract
The authors present an updated assessment of the present state of the macroalgal flora from the Romanian Black Sea waters, after a study that took place between 1999-2009. The research shows that the current algal communities consist of a small number of species, but with considerable biomass. The perennial associations mentioned have declined and the free substratum is now covered by opportunistic species with a short life cycle. Appropriate ways of conservation would be the improvement of physicochemical conditions of coastal waters and maintenance of the under water Marine Reserve "Vama –Veche" in the south part of our coast.
Keywords: Black Sea, Phytobenthos

The Black Sea ecosystem, mainly in its northwestern sector, has changed under the influence of harmful factors which also affected the qualitative and quantitative state of macrophytobenthos [1, 2]. The present paper shows the data obtained after a 10 year survey, compared with previous data [3], in order to point out the changes of this major component of the Black Sea ecosystem. The algae were collected from various types of hard substratum. From each sample, algae were identified and representative individuals were kept for the herbarium collection. For biomass estimation three samples were randomly taken from a surface of 100 cm^2 at depths between 0.5 - 7 m, the algal material was than dried and weighed, in order to obtain the values of dried biomass. In the collected samples, 16 Chlorophyta, 5 Phaeophyta and 10 Rhodophyta were found. Compared with previously reported results, it is quite evident that the number of species from each phylum decreased over the years (Table 1).

Tab. 1. Evolution of macroalgal species between 1977-2002

Phyllum	Bavaru, 1977	Vasiliu, 1980-1995	Sava,1995-2002
Chlorophyta	31	22	16
Phaeophyta	14	9	4
Rhodophyta	41	24	10
Total	86	55	30

The relatively high number of Chlorophyta, compared with other groups can be explained by the fact that eutrophication seems to favor the development of green algae. The quantitative data emphasized that green and red algae were dominant, with a significant decrease after 2004 that can be related to the amelioration of the state of the marine ecosystem along the Romanian shore in recent years, which could have beneficial consequences on the whole algal vegetation. Generally, our present observation confirms previous studies: qualitative decline, high biomass of *Enteromorpha*, *Cladophora* (Chlorophyta) and *Ceramium* (Rhodophyta), the almost disappearance of perennial species (brown alga *Cystoseira*) [4, 5]. The continuous observation of the evolution of physicochemical parameters of shallow waters, and the continuous biodiversity monitoring will allow us to estimate the trend in the near future, because anthropogenic factors are still present and are likely to disturb directly and indirectly the ecosystem and community structure in the Black Sea.

References
1 - Bologa A.S., Bodeanu N., Petran A., Tiganus V., Zaitzev Y., 1995.: Major modifications of the Black Sea benthic and planktonic biota in the last three decades In: *Les mers tributaires de Mediteranee* - F.Briand (ed) -Bulletin de L'institute oceanographique Monaco, no special 15: 85-110

2 - Petran A., Mukader A., Bodeanu N., Bologa A.S., Dumitrache C., Moldoveanu M., Gheroghe R., Tiganus V.,1999: Status and evolution of Romanian Black Sea Coastal Ecosystem In: *Environmental Degradation of the Black Sea*, S.T.Besiktepe et al. (Eds.), NATO Scienc Series, 2.Env.Security-vol.56: 175-195, Kluwer Acad.Press, Dordrecht/Boston/London,

3 - Bavaru A., Bologa A.S., Skolka H.V., 1991: A cheklist of benthic marine algae (except the Diatoms) along the Romanian shore of the Black Sea *Oebalia* - International Journal of Marine Biology and Oceanography, Taranto, Italy 17, 2 suppl.19:535-551

4 - Sava D., Doroftei E, Bavaru A., 2001: Major modifications of the macrophytic algal flora under the influence of anthropogenic factors in coastal Romanian Black Sea waters -*Phycologia* -Journal of the International Phycological Society, pp 110

5 - Sava D., Arcus M., Doroftei E., Busuricu F., Balaban D.P., 2003 – The latest data on the qualitative structure of macrophytobenthos from the Romanian Black Sea shore. *4th Int. Conf. PH students*, Miskolc, Hungary: 365-370

DISTRIBUTION AND BIOLOGY OF TWO SYMPATRIC *PHALERIA* SPECIES (COLEOPTERA: TENEBRIONIDAE) ON MALTESE SANDY BEACHES

Alan Deidun [1]*, Antonia Pawley [1] and Patrick J Schembri [1]
[1] Department of Biology, University of Malta - alan.deidun@um.edu.mt

Abstract

Differences in the zonation and habitat preferences of two sympatric *Phaleria* species on five Maltese sandy beaches were investigated. *P. bimaculata* has a more seaward zonation than *P. acuminata* and occurs at higher densities. Behavioural aspects of the two species were also investigated in the laboratory through the use of choice chambers. The two species have similar sand moisture content and grain-size preferences, and a similar phenology, but different sand organic content preferences
Keywords: Beach, Behaviour

Introduction

Beetles of the genus *Phaleria* are one of the major consumers of debris on sandy beaches in the Mediterranean. The coexistence of different species of *Phaleria* on Mediterranean islands has been well documented [1, 2]. One such species-pair – *Phaleria acuminata* and *Phaleria bimaculata* - occurs in the Maltese Islands [3], with the two species being sympatric on some beaches and allopatric on others. Zonation along the shore, sand moisture content, sand organic content and sediment grain-size preferences, as well as seasonal variation in abundance, were investigated for the two species.

Materials and Methods

Five Maltese sandy beaches (Mgiebah, Golden Bay, and White Tower Bay on Malta, and Ramla l-Hamra and Xatt l-Ahmar on Gozo) were sampled during different seasons in 2001-2003 and in 2006-2007 by means of pitfall traps placed at regular intervals between the strandline and the vegetated margins of the beach. At each station, two plastic cups were buried flush with the sand surface and connected by wooden walkways that acted to deflect animals into the traps; traps were left overnight. For behavioural experiments, individuals of both species were tested separately in a series of choice chambers (glass troughs) presenting, in separate trials, choices between sand with different (i) moisture content, (ii) organic content, and (iii) grain size. At the end of each trial the number of *Phaleria* individuals in each compartment of the choice chamber was recorded by sieving out the sand and counting the number of individuals.

Results and Discussion

The *Phaleria* species occurred sympatrically on two beaches (Golden Bay, Mgiebah) and allopatrically on the other three (*Phaleria acuminata* – Ramla l-Hamra; *Phaleria bimaculata* – Xatt l-Ahmar and White Tower Bay). On Mediterranean beaches with sympatric *Phaleria*, the two species normally occupy different zones (e.g. [2]). In the present study, sympatric *P. bimaculata* had a more seaward distribution than *P. acuminata*; peak densities of *P. bimaculata* and *P. acuminata* occurred at a mean distance of 9m and 41m away from mean sea-level (MSL), respectively. Additionally, *P. bimaculata* was consistently recorded in higher densities than *P. acuminata* on beaches where the two species were sympatric (mean capture frequency: *P. bimaculata* = 3.35±5.33SD inds/trap/hr; *P. acuminata* = 0.97±1.06SD inds/trap/hr). Whilst such interspecific differences in position on the shore have been attributed to differences in sand moisture preferences [3], no significant differences in sand moisture preferences for the two *Phaleria* species were found in the choice experiments made in the present study. Zonation of sympatric *Phaleria* species could be due to a preference for different sand grain sizes [4] but again, choice-chamber experiments made in the present study did not show significant differences between the grain-size preferences of the two species, while all the beaches sampled were characterized by 'medium sand' (Wentworth-Udden scale), except for the wet zone of White Tower Bay (medium/fine sand), where only *P. bimaculata* was recorded. A temporal variation in abundance of sympatric species-pairs of *Phaleria* has been suggested [3]; the results of the present study as well as of a previous one [5] do not support this since the sympatric *Phaleria* species showed similar seasonal patterns, with the highest abundances recorded in the spring and the lowest in autumn in both species. The present study did not identify any beach physical parameter that modulates the zonation and abundance of the two species, and in Malta at least, *P.acuminata* and *P.bimaculata* appear to have a high degree of niche overlap. However, in behavioural experiments, *P. bimaculata* exhibited a significantly (p=0.05) higher preference for organically enriched sand than *P. acuminata*, hinting at possible niche partitioning in terms of feeding preferences. It has been suggested that *Phaleria* species make good bio-indicators of the health of beach ecosystems [6], however, before they can be used as such, a good knowledge of their ecology and behaviour is necessary, especially when different species occur sympatrically. *P. bimaculata* was previously recorded from Ramla l-Hamra ([7], but was not found there in other studies (e.g. [5]), including the present one. This may either mean that the species has become extinct from this beach or else that the population here is so small and patchily distributed that it is not easily sampled; in either case, this underlines the precarious nature of populations of psammophilic species in localities such as the Maltese Islands where sandy beaches are few and small and under heavy anthropogenic pressure [8].

References

1 - Fattorini, S. and Leo, P., 2000. Darkling beetles from Mediterranean minor islands: new records and biogeographical notes. *Boll. Soc. Ent. Ital.*,132(3): 205-217.

2 - Colombini, I., Fallaci, M. and Chelazzi, L., 2005. Micro-scale distribution of some arthropods inhabiting a Mediterranean sandy beach in relation to environmental parameters. *Acta Oecol.*, 28: 249-265

3 - Fallaci, M., Colombini, I. and Chelazzi, L., 1994. An analysis of the Coleoptera living along a Tyrrhenian beach-dune system: abundances, zonation and ecological indices. *Vie Milieu*, 44(3/4): 243-256.

4 - Canzoneri, S., 1968. Materiali per una monografia delle *Phaleria* del sottogenere *Phaleria* Latreille. *Mem. Soc. Ent. Ital.*, 47: 117-167.

5 - Borg, J., Deidun, A. and Schembri, P.J., 2004. Population ecology of *Phaleria acuminata* (Coleoptera: Tenebrionidae) from sandy beaches in the Maltese Islands, *Rapp. Comm. Int. Mer Medit.*, 37: 496.

6 - Fallaci, M., Aloia, A., Colombini, I. and Chelazzi, L., 2002. Population dynamics and life history of two *Phaleria* species (Coleoptera, Tenebrionidae) living on the Tyrrhenian sandy coast of central Italy. *Acta Oecol.*, 23: 69-79.

7 - Mifsud D., 1999. Tenebrionids associated with sandy shores in the Maltese Islands (Coleoptera, Tenebrionidae).*The Central Mediterranean Naturalist*, 3 (1): 23-26.

8 - Cassar L. and Stevens D., 2002. Coastal sand dunes under siege. A guide to conservation for environmental managers. International Environment Institute. Foundation for International Studies. Valletta, Malta: 194pp.

DISTRIBUTION OF *TYLOS* SPP. (CRUSTACEA, ISOPODA) ON MALTESE SANDY BEACHES AND OBSERVATIONS ON *TYLOS EUROPAEUS*.

Alan Deidun [1]*, Francesca Galea Bonavia [1] and Patrick J Schembri [1]
[1] Department of Biology, University of Malta - alan.deidun@um.edu.mt

Abstract
The occurrence of *Tylos europaeus* and *T. sardous* on 10 Maltese beaches was investigated. *T. europaeus* occurred on two beaches on Gozo and *T. sardous* on a single beach on Malta. The largest population was of *T. europaeus* at Ramla l-Hamra on Gozo, but even here the isopods occupied a limited zone close to sea-level. The diurnal and nocturnal distribution of this population as well as temporal changes in distribution pattern over two years were studied in order to provide baseline information for the conservation of this rare psammophile in the Maltese Islands.
Keywords: Beach, Conservation, Biodiversity, Coastal Systems

Introduction
Only 2.4% of the Maltese coastline is sandy [1]. This, and the intense human activity on beaches during the summer months, make most sand-associating species rare and potentially threatened, particularly if they are strictly psammophilic. Two species of the psammophilic isopod genus *Tylos*, *T. europaeus* and *T. sardous*, occur in the Maltese Islands [2], both of which appear to be rare not only because their habitat is limited, but also because even where they occur their populations are not large. To provide baseline information on these species in the Maltese Islands, their distribution on the larger beaches was studied by sampling surface-active animals at night and animals buried in the sand during the day. One beach had a relatively substantial population of *T. europaeus*, which allowed more detailed observations on the spatial and temporal distribution of this species to be made.

Material and Methods
Pitfall traps were deployed 1m apart along shore-normal transects extending from mean sea-level (MSL) landwards, on 10 sandy beaches in the Maltese Islands. Each trap was set flush with the sand surface and was separated from adjacent traps by a 1m wooden walkway to deflect wandering animals towards the traps. Traps were deployed for eight seasons over two successive years (2002-2003). The daytime distribution of *Tylos europaeus* buried in the sand was studied at Ramla l-Hamra, Gozo, where the largest population occurs [3]. A 30x30cm quadrat was deployed at 1m-intervals along a shore-normal transect in the wet zone of the beach and at 1m, 3m, 5m and 10m intervals from the strandline in the dry zone. Sand within the quadrat was removed and wet sieved through a 0.5 mm mesh; this procedure was carried out successively for the 0-10 cm, 10-20cm and 20-30cm depth strata of the sand within each quadrat.

Results and Discussion
Of the 10 beaches sampled, *Tylos* were only found on three: Ramla l-Hamra and San Blas on Gozo, and Paradise Bay on Malta. The sand from all three beaches had a median particle diameter of 0.25mm, classifying it as fine sand on the Wentworth Scale. Although *Tylos* was previously recorded from Mistra Bay [2], no individuals were collected from this site in the present study. The specimens from Ramla l-Hamra and San Blas were identified as *Tylos europaeus* on the basis of pleon morphology, while those from Paradise Bay were identified as *Tylos sardous*. The abundances of *T. europaeus* at San Blas and of *T. sardous* at Paradise Bay were very low (individual abundances of 0.05inds/trap/hr for *T. europaeus* at San Blas and 0.26inds/trap/hr for *T. sardous* at Paradise Bay) and these populations were not studied further. In summer, the daytime distribution of *T. europaeus* at Ramla l-Hamra was limited to a narrow zone 3-7m above mean sea level. Within this zone, adult population density ranged from 220 to 450 individuals/m^3 but juveniles had densities of 450-3200 individuals/m^3. Individuals were found at all three depth strata within the sand (0-10 cm, 10-20cm and 20-30cm), with most adults in the deepest stratum while juveniles were mainly restricted to the upper stratum. During winter, juveniles were again more abundant than adults at almost all the stations, but the isopods were recorded from the surface (0-10 cm) depth stratum only. Adults occurred in higher abundances than juveniles in the pitfall trap collections over all the eight sampling seasons except summer 2002 and summer 2003, and males outnumbered females at all times. Gravid females were found in the spring of both 2002 and 2003, implying that reproduction occurs once a year, as already noted by others (e.g. [4]), and that the preponderance of juveniles in summer was the result of recruitment.

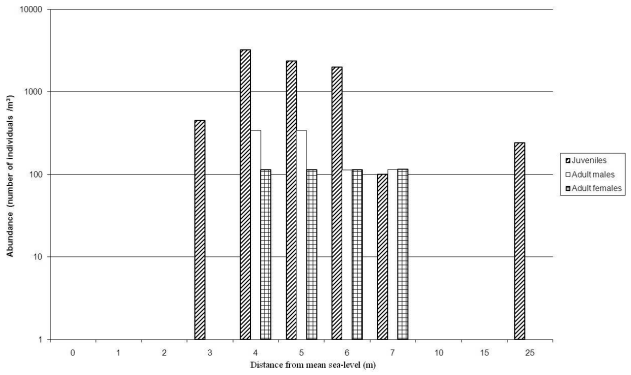


Fig. 1. Distribution of juvenile, adult male and adult female *Tylos europaeus* in the upper 0-10cm layer of sand relative to mean sea-level at Ramla l-Hamra, Gozo.

At Ramla - l Hamra, T.europaeus showed a clear seasonal shift in distribution along the shore, with individuals being zoned further away from MSL during the autumn and winter, and shifting progressively seaward during the spring and summer months, as also observed for the species on a Tyrrhenian beach [5]. There was a high degree of inter-annual variation in abundance of surface-active animals; just four individuals were collected in the pitfall traps in winter 2003, as compared to 619 individuals in winter 2002; this is probably related to colder air temperatures during the winter of 2003 which may have resulted in more inactive individuals. It has been suggested [5] that adverse climatic conditions, especially low air temperatures, could become a limiting factor and depress surface activity in *T. europaeus*. Although common on Mediterranean shores, both species of *Tylos* are overall rare in the Maltese Islands, especially *T. sardous*, which appears to only occur on a single beach, and even where found, populations are restricted to a limited zone of the shore. Therefore, if such species are to continue to survive locally, some management of the populations is necessary and studies such as the present one provide basic information on the populations on which conservation management actions may be based.

References
1 - Mallia, A., Briguglio, M., Ellul, A.E. and Formosa, S., 2002. Physical background, demography, tourism, mineral resources and land-use. *State of the Environment Report for Malta, 2002.* pp.43-169. Malta: Ministry for Home Affairs and the Environment.
2 - Hili, C., 1990. *The terrestrial isopod fauna of the Maltese Islands*. Unpublished B.Ed. dissertation, Faculty of Education, University of Malta.
3 - Deidun A., Azzopardi M., Saliba S. and Schembri P.J., 2003. Low faunal diversity on Maltese sandy beaches: fact or artefact? *Estuar. Coast. Shelf Sci*., 58: 83–92.
4 - Hayes, W.B., 1977. Factors affecting the distribution of *Tylos punctatus* (Isopoda, Oniscoidea) on beaches in Southern California and Northern Mexico. *Pacific Sci*., 31: 165- 186.
5 - Fallaci, M., Colombini, L., Taiti, S. and Chelazzi, L., 1996. Environmental factors influencing the surface activity and zonation of *Tylos europaeus* (Crustacea: Oniscidea) on a Tyrrhenian sandy beach. *Mar. Biol*., 125: 751- 763.

WINTER TRENDS IN THE NORTHERN ADRIATIC

Tamara Djakovac [1], Romina Kraus [1]*, Robert Precali [1] and Nastjenjka Supic [1]
[1] Rudjer Boskovic Institute, Centre for Marine Research - kraus@cim.irb.hr

Abstract
Winter (February) phytoplankton blooms characterise the northern Adriatic. A significant decrease of winter phytoplankton abundance in the western part and an increase in the eastern one during the 1990-2007 period was observed. Furthermore, salinity and nutrient winter trends in the western and eastern part of the northern Adriatic differ as well. An interpretation of the observed changes was required.
Keywords: Adriatic Sea, Nutrients, Phytoplankton, Po Delta, Salinity

Introduction
The northern Adriatic is one of the most productive regions of the Mediterranean Sea. A well defined eutrophication gradient decreases eastwards, mainly due to the Po River discharge [1], leading to a significantly higher phytoplankton abundance in the western part. Especially high phytoplankton blooms appear in winter (February). Blooms are especially intense when waters from the Po River spread over the large northern Adriatic area (in prep.). We are presenting western and eastern winter trends in phytoplankton abundances, salinity and nutrient concentrations for the 1990-2007 period.

Methods
Phytoplankton (20-200 µm), salinity and nutrient (total inorganic nitrogen and orthophosphate) samples were collected in February at stations SJ108 and SJ107 at standard oceanographic depths along the along the Po River Delta - Rovinj transect for the 1990-2007 period (Figure 1). Parameters were determined by standard oceanographic methods.

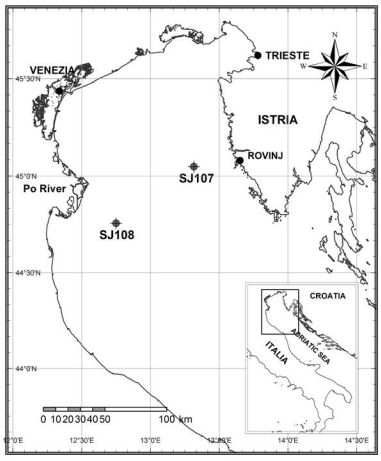


Fig. 1. Northern Adriatic map with sampling stations

Results
In the western part (SJ108), surface phytoplankton abundances and nutrient concentrations decreased, while in the eastern one (SJ107) they increased over the last 20 years. Salinity of the surface layer showed an opposite trend (Figure 2). Phytoplankton abundances *vs*. nutrients and salinity showed a positive and negative correlation, respectively.

Conclusion
Winter trends in phytoplankton abundances in the western and the eastern part of the northern Adriatic in the 1990-2007 period significantly differ and correspond to trends in salinity and nutrient concentrations. Decreasing trends in the western (eutrophic) and increasing ones in the eastern (oligotrophic) part were observed. We suppose that the observed phytoplankton and nutrient decreasing trends in the western part of the northern Adriatic ecosystem were a direct consequence of the extreme change in the Po River freshwater inflow (in prep.). However, the eastern conditions could be probably assigned to circulation regime changes.

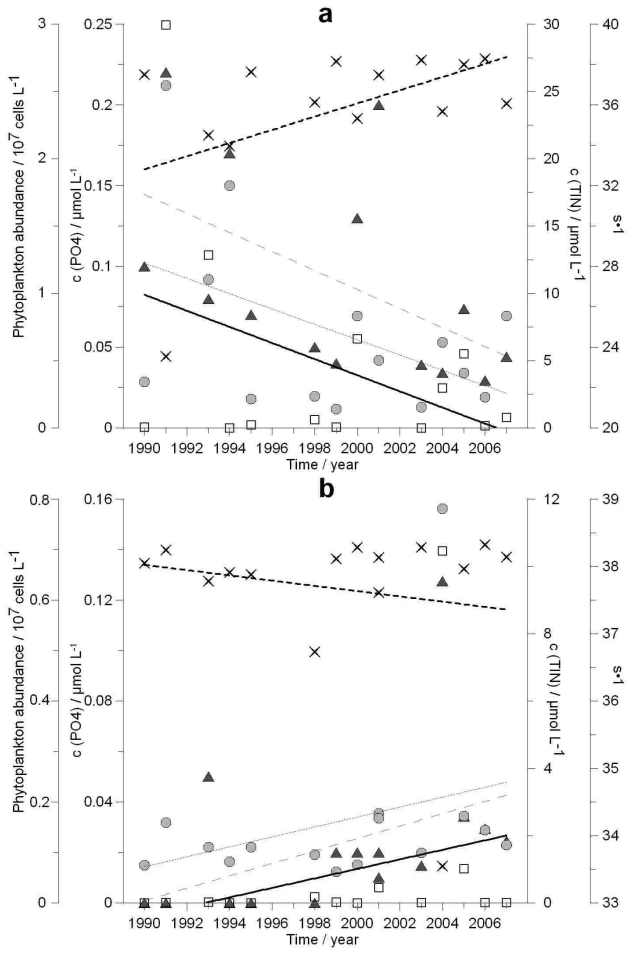


Fig. 2. Phytoplankton abundance (open square, bold-solid line), salinity – s (x-sign, bold-dashed line), total inorganic nitrogen – TIN (grey circle, dot line) and orthophosphate concentration – P (solid triangle, dashed line) in the western part of the northern Adriatic – station SJ108 (a) and in the eastern – station SJ107 (b) during the period 1990-2007 with corresponding linear fit lines

References
1 - Degobbis D., Precali R., Ivancic I., Smodlaka N., Fuks D. and Kveder S., 2000. Long-term changes in the northern Adriatic ecosystem related to anthropogenic eutrophication. *Int. J. Envir. and Pollut.*, 13 (1-6): 495-533.

SENSITIVITY MAPPING OF THE FRENCH MEDITERRANEAN COASTAL ENVIRONMENT

Céline Duffa [1], Carolyn Scheurle [1] and Hervé Thébault [1]*
[1] Institut de Radioprotection et de Sûreté Nucléaire - herve.thebault@ifremer.fr

Abstract
In case of any accidental marine pollution, the vulnerability of coastal zone not only depends on the extent and type of pollution, but also on the environmental and socio-economic characteristics. Therefore, to allow decision makers and experts to assess their decisions on synthetic and operational information, an atlas of sensitivity for French Mediterranean coastal environments is produced. The estimated sensitivity, defined for each delimited section of the coast, is based on many physical, ecological and socio-economical criteria.
Keywords: Coastal Systems, Gis, Pollution, Economic valuation

Introduction
Today, about 30% of the international maritime traffic concern Mediterranean harbours or are on transit and estimated 50% of the transported merchandises are supposed to present a risk (Aprin et al. 2008). An accidental release of hydrocarbons or chemicals is rendering the marine and coastal zones vulnerable. In order to face such accidental marine pollutions and their consequences, specifically adapted coastal management strategies and decision making processes are needed. Within this context, the project CLARA II (Calculs Liés Aux Rejets Accidentels en Méditerranée; http://clara2.ema.fr) aims to provide a decision support tool focussing on the French Mediterranean. Among other things, this tool will provide a sensitivity atlas of the French Mediterranean coast. Produced sensitivity maps are used to support decision makers and experts to prepare the interventions and to first estimate the consequences in case of pollution.

Methodology
In order to establish the respective sensitivity maps, the French Mediterranean coast (including Corsica) has been divided in zones. Taking into account main environmental characteristics as well as requirements to management and decision making processes in case of an accident, 32 zones have been distinguished. Seawards they are limited by four miles and/or 50 meters depth. The collection embraces information and data on the various environmental (physical, dynamical and biological) and socio-economic characteristics. Face to any marine pollution, these stakes presence and importance will contribute to increase or decrease the vulnerability of a zone. Therefore, we consider them as sensitivity factors. Their individual values are evaluated on a sensitivity scale from 1 (less sensitive) to 5 (very sensitive), which translates their relative importance. For instance, south Corsica zones present a high sensitivity considering risk on protected areas (see Figure 1). While distinguishing the summer and winter season, this will be done fore each of the 32 zones and for each type of pollutant studied. On this basis, a "global" index (encompassing the environmental and economical indices) is calculated for each of the zones and the two seasons. This step of the study is accompanied by a multi-criteria study, based on different point of view to give a relative weight to each factor. In order to homogenise and treat the spatial data we use a Geographic Information System (Arc GIS9 ESRI).

Results and Conclusions
Sensitivity indices are attributed to all selected and collected data: Environmental factors (e.g. biodiversity, protected areas, cost morphology), and socio-economical factors (e.g. fisheries and aquaculture as well as tourist and recreational activities). While distinguishing the summer and winter season, this is done fore each of the 32 zones and for each type of pollutant studied. The resulting sensitivity maps aim to geographically represent the sensitivity indices of one zone relative to another zone. A correspondence to so-called absolute values is not intended.

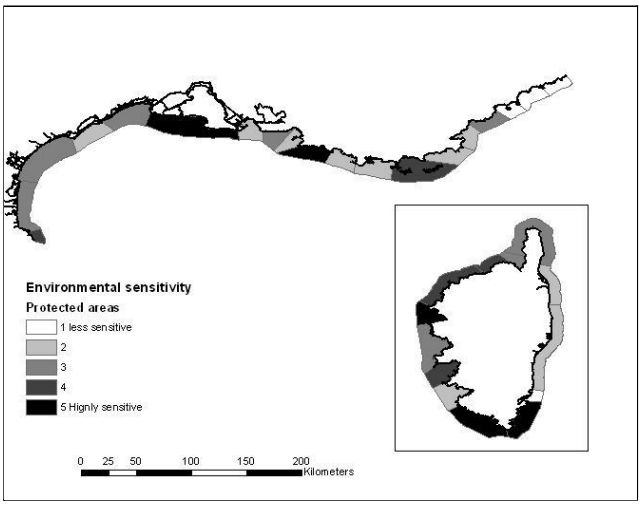


Fig. 1. French Mediterranean Sensitivity relative to existing protected areas

Firstly dedicated to the French Mediterranean coast, moreover, the concept aims to create standardized tools which make it possible to represent and compare the sensitivity of various coastal environments. Our preliminary results underline the potential to transfer the approach, and encourage the possibility for an application beyond the immediate objectives of the project CLARA II.

References
1 - Aprin, L., Lefloch, S., Garreau, P., James, A., Daniel, P., Daumail, V., Sanchez, C., Mouries, M., Casselman, C., Thébault, H., Etasse, C., Roure, J.F., Mercantini, J.M., Olier, R., 2008. « Développement d'un outil informatique opérationnel d'aide à la décision et de modélisation des pollutions en Méditerranée », 16ème Congrès de Maîtrise des Risques et de Sûreté de Fonctionnement - Avignon 6-10 octobre 2008, communication 1Z-8, 8p.

LES SELS NUTRITIFS AU NIVEAU DU LITTORAL DU GOLFE DE GABÈS (TUNISIE)

J. Elloumi [1]*, W. Guermazi [1], Z. Drira [1], A. Hamza [2], L. Aleya [3], A. Bouaïn [1] and H. Ayadi [1]
[1] Université de Sfax, Faculté des Sciences de Sfax, Département des Sciences de la Vie. Unité de recherche UR/05ES05 Biodiversité et Ecosystème Aquatiques, Route soukra Km 3,5, B.P. 1171, CP 3000 Sfax, Tunisie - elloumijannet@yahoo.fr
[2] Institut National des Sciences et Technologie de la Mer. Centre de Sfax BP 1035 Sfax 3018, Tunisie
[3] Université de Franche-Comté, Laboratoire de Chrono-Environnement, UMR CNRS 6249. 1, Place Leclerc, F-25030 Besançon cedex, France

Abstract
L'objectif de ce travail consiste à suivre la répartition spatiale des éléments nutritifs (NH_4^+, NO_2^-, NO_3^-, PO_4^{3-}, N-T, P-T et N/P) au niveau de 15 stations côtières du Golfe de Gabès. Les résultats montrent que le Golfe de Gabès représente une limitation en azote et que le statut trophique de la zone étudiée est oligotrophe.
Keywords: Gulf Of Gabes, Nutrients

Introduction
Le Golfe de Gabès est caractérisé par un climat pré-saharien aride à semi aride, et par une faible pluviométrie dont la moyenne annuelle est de 200 mm an^{-1}. Le Golfe de Gabès est situé sur la façade Sud-est de la Tunisie. Il s'étend de "Ras Kapoudia" au niveau de la parallèle 35°N jusqu'à la frontière tuniso-lybienne. Il abrite les îles Kerkennah, Kneiss et Jerba et les lagunes de Bougrara et d'El Bibane [1]. Au cours de cette étude, nous avons souhaité évaluer le statut trophique des eaux côtières du Golfe de Gabès.

Matériel et méthodes
Les échantillons ont été collectés mensuellement dans le cadre du réseau de surveillance phytoplanctonique REPHY, entre mars 2006 et février 2007 au niveau de 15 stations peu profondes (< 1 m).
Les échantillons ont été collectés à l'aide d'une bouteille fermante de type Van Dorn entre 10 à 20 cm de profondeur et conservés à -20°C et à l'obscurité jusqu'au jour de l'analyse.
Le dosage des éléments nutritifs (nitrate (NO_3^-), nitrite (NO_2^-), l'azote ammoniacal (NH_4^+), l'ion orthophosphate (PO_4^{3-}), l'azote total (N-T) et le phosphore total (P-T)) (après minéralisation respectivement en ions NH_4^+ et en ions PO_4^{3-} suite à une réaction avec le potassium persulfate à 120°C) a été réalisé en flux continu par un auto-analyseur (BRAN + LUEBBE) de type 3 selon le principe colorimétrique en utilisant un spectrophotomètre UV-visible (6400/6405) [2].

Résultats et discussions
Les teneurs en éléments nutritifs sont présentés au niveau du tableau 1.

Tab. 1. Les concentrations Moyenne ± écart type des éléments nutritifs (µmol l^{-1}) et du rapport N/P. La dernière ligne donne les résultats d'analyse statistique (ANOVA). * Différence significative entre les stations échantillonnées (*p<0.05, **p<0.01, ***p<0.001)

	NH_4^+ (µmol l^{-1})	NO_2^- (µmol l^{-1})	NO_3^- (µmol l^{-1})	PO_4^{3-} (µmol l^{-1})	N-T (µmol l^{-1})	P-T (µmol l^{-1})	N/P
Tabia	2.5 ± 1.4	0.3 ± 0.2	2.0 ± 1.2	0.8 ± 0.4	19.6 ± 5.0	5.7 ± 4.8	6.1
Ras Younga	3.3 ± 2.6	0.4 ± 0.4	1.7 ± 1.1	0.7 ± 0.3	19.4 ± 5.0	5.0 ± 2.9	7.8
Jaboussa	2.9 ± 2.3	0.2 ± 0.2	1.5 ± 1.2	1.3 ± 1.3	21.5 ± 6.9	5.3 ± 5.2	3.5
Tarfelma	3.5 ± 2.3	0.6 ± 0.5	2.8 ± 1.9	0.6 ± 0.7	22.7 ± 4.9	3.7 ± 2.2	10.8
El Hicha	3.7 ± 1.9	0.5 ± 0.7	3.0 ± 0.9	1.0 ± 1.1	20.1 ± 5.6	4.1 ± 3	7.4
Port de Gabès	4.0 ± 2.4	0.7 ± 0.5	3.2 ± 3.0	1.6 ± 2.4	25.6 ± 9.1	8.6 ± 10.2	5.1
Zarrat	3.3 ± 1.9	0.4 ± 0.3	2.2 ± 1.1	1.3 ± 0.9	20.1 ± 6.1	7.3 ± 5.5	4.5
El Grine	3.8 ± 3.3	0.4 ± 0.3	1.7 ± 0.9	0.9 ± 1.0	19.1 ± 5.7	3.8 ± 1.7	6.3
Maghraouia	3.8 ± 2.6	0.2 ± 0.1	2.3 ± 2.8	1.0 ± 0.9	20.6 ± 9.7	4.8± 1.9	6.2
Karboub	5.7 ± 3.3	1.0 ± 1.0	3.1 ± 0.9	0.5 ± 0.3	23.3 ± 8.9	4.0 ± 1.5	18.3
Hassi Jerbi	5.0 ± 3.7	0.7 ± 0.8	3.6 ± 2.8	0.5 ± 0.4	25.5 ± 7.7	2.5 ± 1.8	19.3
Cheikh Yahia	3.4 ± 2.0	0.9 ± 1.6	2.6 ± 1.3	1.1 ± 0.9	21.2 ± 9.1	5.5 ± 3.3	6.2
Borj Djelijel	2.6 ± 1.7	0.4 ± 0.4	3.4 ± 3.4	0.6 ± 0.4	22.0 ± 6.0	4.2 ± 3.3	10.1
Jabiat Haj Ali	3.9 ± 3.2	0.5 ± 0.5	2.2 ± 1.9	0.8 ± 0.7	20.4 ± 7.4	3.3 ± 1.8	8.4
Cannel de Cotusal	5.7 ± 5.4	0.5 ± 0.5	2.9 ± 2.1	0.5 ± 0.3	23.7 ± 7.9	3.0 ± 2.1	19.7
F	1.61	1.82*	1.41	2.93***	1.65	3.66***	

Les concentrations moyennes d'azote total (N-T) varient entre 19.1 ± 5,7 µmol l^{-1} au niveau de la station El Grine et 25.6 ± 9.1 µmol l^{-1} au niveau du port de Gabès. Les concentrations en nitrate (NO_3^-) ne diffèrent pas entre les stations et elles représentent les concentrations les plus élevées 3.6 ± 2.8 µmol l^{-1} au niveau de Hassi Jerbi. Les concentrations en NO_2^- sont très faibles (ANOVA, F=1.82, p<0.05) et ne dépassent pas 0.5 µmol l^{-1} à l'exception des stations de Tarfelma, le Port de Gabès, Karboub, Hassi Jerbi et Cheikh Yahia où les concentrations sont plus importantes. Dans toutes les stations, les concentrations en ions ammonium ne présentent pas de différence significative et sont élevées (> 2 µmol l^{-1}). Les concentrations en phosphore total et en ion orthophosphate montrent une différence significative entre les stations (ANOVA, F=3.66, p<0.001 et F=2.93, p<0.001 respectivement). Les valeurs les plus élevées en phosphore total sont enregistrées dans les stations Zarrat et Port de Gabès (Tableau 1). Les concentrations en PO_4^{3-} sont élevées au niveau des stations Zarrat, Port de Gabès et Jaboussa (Tableau 1). Le rapport N/P: DIN (DIN= NO_2^-+ NO_3^- + NH_4^+) sur DIP (DIP= PO_4^{3-}) varie de 3.5 au niveau de la station Jabousssa à 19.7 dans le canal de Cotusal. Dans la majorité des stations le rapport N/P est inférieur à celui de Redfield (16), à l'exception de Karboub, Hassi Jerbi et Cannel de cotusal où le rapport N/P représente 18.3, 19.3 et 19.7 respectivement, ce qui confirme une limitation en azote due à l'utilisation excessive des formes azotés par les bactéries et le phytoplancton. Cette observation est semblable aux résultats des eaux côtières du Golfe de Gabès [1], confirmant que le bassin méditerranéen oriental est un écosystème «oligotrophe» [1,3].

References
1 - Drira Z., Hamza A., Belhassen M., Ayadi H., Bouaïn A. and Aleya L., 2008. Dynamics of dinoflagellates and environmental factors during the summer in the Gulf of Gabes (Tunisia, Eastern Mediterranean Sea). *Sci. Mar.*, 72: 59-71.
2 - APHA, 1992. Standard methods for examination of water and wastewater. American Public Health Association, Washington, DC, 18th Ed.
3 - Heurt B., Zohary T., Krom M.D., Fauzi R., Mantoura C., Pitta P., Psarra S., Rassoulzadegan F., Tanaka T., Thingstad T.F., 2005. Response of east Mediterranean surface water to Saharan dust: On-board microcosm experiment and field observations.*Deep-Sea Res. II*., 52 : 3024-3040.

SPILLOVER EFFECTS OF A MARINE PROTECTED AREA ON A EXPLOITED LOBSTER *PALINURUS ELEPHAS* RESOURCE

Maria cristina Follesa [1]*, Danila Cuccu [1] and Angelo Cau [1]
[1] Department of Animal Biology and Ecology, University of Cagliari, Italy - follesac@unica.it

Abstract
We investigated the effects of the Su Pallosu marine protected area (Central western Mediterranean) on the adjacent *Palinurus elephas* (Fabricius, 1787) fishery. After 11 years of no-take protection, a gradient of the lobster biomass (Catch Per Unit Effort) from the interior of the reserve up to a distance of about 20 km from its centre was found. CPUE showed non linear decline with distance from the centre of the reserve.
Keywords: Decapoda, Marine Parks, Western Mediterranean

Introduction
Fishing restrictions in a marine protected area (MPA) can promote an increase in biomass of species leading to a spillover to surrounding commercial areas and enhancing local fisheries [1,2,3]. After 11 years of absence of fishing activity, we investigate spillover from Su Pallosu MPA (CW Mediterranean) to commercial fishing zones based on the effects on artisanal local fisheries of lobster.

Materials and methods
The study was carried out in the Su Pallosu marine protected area of the central-western Sardinia (central-western Mediterranean) and its surrounding commercial zones. The area (4 km^2 area), identified in 1997, was closed to the fishing since 1998 (Regional Law No. 776 of 6-5-1998). Catch data were collected in 2008 during the annual lobster fishing season (May-September) onboard of artisanal commercial boats equipped with trammel net. Specifically, commercial data of 4 different local boats (Seleca, Monè, Marlin and Queen of sea) selected on the base of the main distance of their operative fishing zone from the centre of the protected area, were registered. Experimental fishing surveys inside the area by the same commercial boats were also performed. The geographic positions of the start and end of each fishing set were recorded. CPUE was calculated by the weight (kg) of lobsters caught per meter of trammel net per boats.

Results
The experimental main CPUE inside the reserve was 10.72±7.27 kg/boat/meter net. An evident progressive declining gradient of commercial CPUE values increasing the distance from the centre of the protected area was observed (Fig. 1). Commercial fishing data in fact show the existence of a negative lobster abundance up to 5 km away the protected area. Over 10 km from the centre of the MPA the commercial CPUE values settled to about 0,2 kg/boat/meter net (Fig.1).

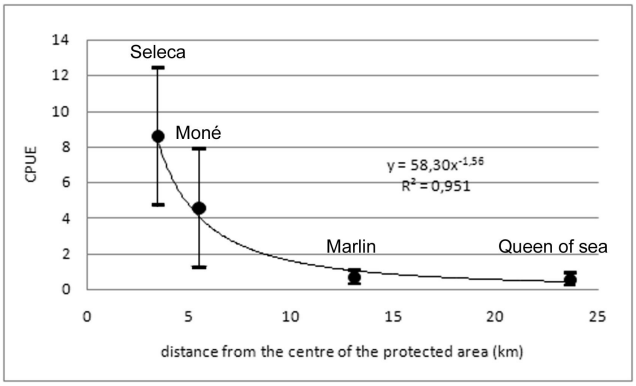


Fig. 1. Commercial mean CPUE (kg of lobster caught per boat per meter net) ± sd versus the main distance of each boat's operative fishing zone from the centre of the protected area

Conclusions
Net emigration of animal across reserve boundaries should create a gradient of density as results of the movement behavior and catchability and exploitations rate of the species in the adjacent fishery (Russ et al. 2003). In our study the limited mobility of *Palinurus elephas* (60.4% of lobsters moved less than 2 km from the centre of the area, [4]) jointed to the reduced dimension of the protected area (4 km^2) and the high fishing pressure across the boundary seem to be the main factors that should have conducted to gradually reduce to the availability of lobsters as distance increased.

References
1 - Sanchez-Lisazo JL., Goni R., Renones O ., Garcia Charton JA., Galzin R., Bayle J., Sanchez-Jerez P., Perez Ruzafa A. and Ramos AA., 2000. Density dependence in marine protected populations : A review. *Environ. Conserv*. 27 :144-158.
2 - Russ GR., 2002. Yet another review of marine reserves as reef fishery management tools. *In*: Sale P. (ed) Coral reef fishes. Accademic Press, San Diego, CA, p.421-443.
3 - Russ GR., Alcalà AC and Maypa AP., 2003. Spillover from marine reserves: the case of Naso vlamingii at Apo Island, central Philippines. *Mar. Ecol. Prog*. 132: 1-9.
4 - Follesa M.C., Cuccu D., Cannas R., Sabatini A., Deiana A.M. and Cau A., 2009. Movement patterns of the spiny lobster *Palinurus elephas* (Fabricius, 1787) from a central western Mediterranean protected area. *Scientia marina* 73 (3): 499-506.

MANAGEMENT AND CONSERVATION OF MEDITERRANEAN SEASCAPES: ARE THERE BETTER WAYS TO GO?

S. Fraschetti [1]*, G. Guarnieri [1], S. Bevilacqua [1], J. Claudet [1], A. Terlizzi [1], G. F. Russo [2] And F. Boero [1]
[1] University Of Salento, CoNISMa, 73100 Lecce, Italy - Simona.Fraschetti@Unisalento.It
[2] Università Degli Studi Di Napoli "Parthenope", CoNISMa, 80143 Napoli, Italy

Abstract
Oceans are exposed to a combination of local and global pressures. Effective conservation measures are urgently needed. Several initiatives focused on Mediterranean seascapes by listing habitats and assemblages on the basis of their putative abundance and ecological importance. Our analyses reveal that these classification schemes are questionable in terms of taxa representativeness and basic ecological knowledge of the selected entries. Past efforts had the merit of creating a conservation framework for Mediterranean seascapes, but it is time to make some steps forward, to better account for the changes occurring at Mediterranean scale and to better fit the world wide accepted marine conservation criteria.
Keywords: Biodiversity, Coastal Management, Conservation

Introduction
The Mediterranean Sea is a semi-closed basin exposed to interactions of local and global pressures driving rapid biodiversity changes in terms of species life cycles, trophic interactions, composition, abundance and distribution of assemblages (1, 2). The adoption of measures relying on criteria effectively facing the magnitude of these changes is urgently needed. The EU Habitat Directive is one of the main tools for biodiversity protection in Europe. Marine habitats, however, are treated sparingly in these classification schemes. The RAC-SPA at Tunis (3) tried to react to this superficial treatment of marine habitat diversity focusing on Mediterranean seascapes by listing habitats and assemblages on the basis of their putative abundance and ecological importance. This attempt, together with some others (4, 5), had the merit of creating a framework for Mediterranean seascapes, representing the baseline for the conservation and management of this basin. Here, we analyse this classification to highlight criticalities and propose adjustments to improve the available tools for biodiversity management and protection.

Materials and Methods
The RAC-SPA classification is featured by a hierarchical structure going from the topographic structure of the substrate to the presence of a series of species-assemblages potentially locally dominant (*i.e. facies* and/or *associations*). We used the ISI Web of Science (www.isiknowledge.com) to search published articles dealing with the species/taxa characterizing the *facies* and the *associations* included in the classification.

Results
The classification includes 162 entries (with a total of 128 species included in the list). Our analysis reveals that: 1- The classification scheme is mostly algal-oriented, the 63% of the species being algae (Fig. 1). The genus *Cystoseira* spp. is represented by 13 species, while bioconstructors such as vermetids or bryozoans are included only as general groups. 2. The algal bias, in many cases, allows analyses just in spring-summer, whereas the assemblages typical of winter (e.g. large hydroids) are treated insufficiently. 3- The 14 % of the species considered in the list is not covered by ISI journals and the 16% is cited only once or twice. About half of the included species have been cited by less than ten papers (Fig. 2). 4- There is an important lack of proportion between the entries devoted to shallow assemblages in comparison to those devoted to the so-called circalittoral habitats, which are under represented.

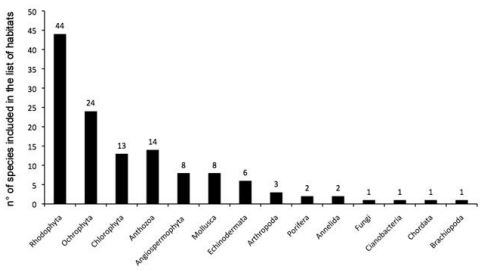


Fig. 1. Number of species for different taxonomic groups in the list of habitats RAC/SPA.

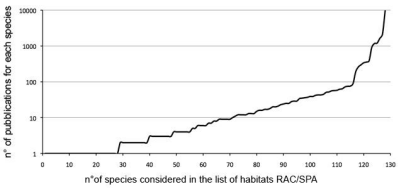


Fig. 2. Number of publications for each species included in the list. Species with 0 publications (n=18) were not reported

Discussion & Conclusion
Our analyses reveal that these classification schemes are taxonomically biased in favour of algae, lack basic ecological knowledge of several selected entries, privilege shallow assemblages and disregard deeper ones and are applicable in some seasons and not in others. Thus, if the aim of the classification is an inventory of dominant habitats, assemblages and species of the Mediterranean Sea, it is awkward to justify the exclusion of a variety of benthic organisms largely represented in this basin. In case the aim is to focus on conservation and management efforts, the inclusion of entries in available lists should be updated, relying on ecological criteria clearly decided *a priori* for deciding which taxa should be "in" and should be "out", based on a general consensus in the scientific community.Past efforts had the merit of creating a conservation framework for Mediterranean seascapes, but it is time to make some steps forward, to better account for the changes occurring at Mediterranean scale.

References
1 - Boero F., Bouillon J., Gravili C., et al., 2008. Gelatinous plankton: irregularities rule the world (sometimes). *Mar Ecol -Prog Series*, 356: 299-310
2 - Garrabou J., Coma R., Bensoussan N., et al., 2009. Mass mortality in Northwestern Mediterranean rocky benthic communities: effects of the 2003 heat wave. *Global Change Biol.*, 15: 1090-1103
3 - RAC/SPA, 2006. Classifcation of benthic marine habitat types for the Mediterranean region. Available online http://www.rac-spa.org/carasp.php?id_page=81
4 - Dauvin J.C., et al., 1994. Typologie des Znieff-Mer, Liste des paramètres et des biocénoses de côtes françaises metropolitaines, 2ème édition. Museum National d'Histoire Naturelle, Paris. 64pp.
5 - Bellan-Santini D., Lacaze J.C., Poizat C., 1994. Les biocénoses marines et littorales de Méditerranée, Synthèse, menaces et perspectives. Collection Patrimoines naturels, Museum National d'Histoire Naturelle publ., 19, 246 pp.

EFFECT OF MULTIPLE DRIVERS ON THE RECOVERY OF MARINE BENTHIC ASSEMBLAGES

Simonetta Fraschetti [1]*

[1] Università del Salento, CoNISMa, 73100, Lecce, Italy - simona.fraschetti@unisalento.it

Abstract

Human threats on the world ocean are multiple and escalating. Effects of multiple stressors can lead to the loss of resilience and an increased risk of regime shifts. The illegal fishery of the date mussel *Lithophaga lithophaga* (L.) is one of the most harmful human activities affecting subtidal rocky habitats in the Mediterranean Sea. I experimentally investigated the interactive effects of nutrient availability and sea urchin grazing on the recovery of subtidal benthic assemblages disturbed by date mussel fisheries. Results suggest that: 1) in enriched plots where grazers were removed, recolonization by macroalgae can be observed in 12 months; 2) the two factors have an antagonist effects; and 3) the presence of grazers imperils the restoration of disturbed assemblages.

Keywords: Biodiversity, Coastal Management, Conservation, Eutrophication, Coastal Processes

Introduction

Multiple stressors act in synergies. Their combined effect can be accumulative, fully additive, multiplicative, mitigative, or under the dominance of one or more stressors. The effects of some anthropogenic stressors are well documented, but the combined effects of multiple stressors are poorly known. Stressors are usually considered in isolation, with simplistic interpretations of the effects of human activities on coastal environments [1, 2]. In the Mediterranean Sea, shallow rocky calcareous habitats are heavily threatened due to the destructive fishery of the European date mussel *Lithophaga lithophaga* (L.), which leads to the desertification of tens of kilometres of rocky coast each year [3, 4]. The effects of this disturbance are well-known but the information is still scarce on patterns of recovery and potential for restoration [5]. We explored, through a manipulative experiment, the interplay between nutrient supply and grazing pressure in shaping the recovery trajectories of benthic assemblages impacted by the date mussel fishery.

Material and Methods

The experiment was carried out for 1 year within 12 square plots of $25m^2$ (2 plots for each combination of factors, plus two control artefacts) at about 6m depth, in the no take zone of the MPA of Porto Cesareo (SE Italy). Plots were sampled 9 times (separated at least by 1 month) through photographic sampling method. 10 randomly replicates of 16x23cm were done for a total of 720 replicates units. The experimental plots were enriched by a slow-release fertilizer (Osmocote-pro 18N:9P:10K, Scotts Company) contained in small mesh bags fixed on the rocky substrates. Four bags were used for each plot selected for the application of this treatment. The presence of grazers was manipulated removing by hand all sea urchins at the beginning of the experiment and every time was necessary through a twice-weekly monitoring activity

Results

Univariate and multivariate analyses showed that grazing pressure significantly affects the resilience of disturbed assemblages, strongly decreasing benthic recovery rates of disturbed assemblages. When herbivores are removed, experimental nutrient enrichment enhances recolonization patterns, significantly increasing the number of macroalgal taxa. Recolonization by macroalgae (such as *Anadyomene stellata* and Dyctiotales) occurred only when grazing activity is removed. The combined effect of herbivores in presence of enriched conditions decreased benthic diversity and cover.

Discussion and Conclusion

Results suggest that 1) in enriched plots where grazers were also removed, recolonization by macroalgae can be observed in less than one year; 2) the two factors have an antagonist effects; and 3) the presence of grazers imperils any potential of restoration of disturbed assemblages. These findings stress that the two drivers could act as antagonistic stressors, so that the restoration of our system can be a difficult task. This experimental study is likely to provide useful indications for the management of disturbed assemblages to promote the recovery of assemblages under different trophic conditions.

References

1 - Crain C.M., Kroeker K., Halpern B.S., 2008. Interactive and cumulative effects of multiple human stressors in marine systems. *Ecology Letters* 11: 1304-1315.

2 - Thrush S.F., Hewitt J.E., Dayton P.K., Coco G., Lohrer A. M., Norkko A., Norkko J., Chiantore M., 2009. Forecasting the limits of resilience: integrating empirical research with theory. *Proceedings of the Royal Society B: Biological Sciences*, 276: 3209-3217.

3 - Fanelli G., Piraino S., Belmonte G., Geraci S., Boero F., 1994. Human predation along apulian rocky coasts (SE Italy) - Desertification caused by *Lithophaga lithophaga* (Mollusca) fisheries. *Marine Ecology Progress Series*, 110: 1-8.

4 - Fraschetti S., Bianchi C.N., Terlizzi A., Fanelli G., Morri C., Boero F., 2001. Spatial variability and human disturbance in shallow subtidal hard bottom assemblages: a regional approach. *Marine Ecology Progress Series*, 212: 1-12.

5 - Bevilacqua S., Terlizzi A., Fraschetti S., Russo G., Boero F., 2006. Mitigating human disturbance: can protection influence trajectories of recovery in benthic assemblages? *Journal of Animal Ecology*, 75: 908-920.

THE RECREATIONAL VALUES OF EUROPEAN COASTAL ECOSYSTEMS AND THE IMPACT OF CLIMATE CHANGE UPON THEM

Andrea Ghermandi [1]* And Paulo A.L.D. Nunes [1]
[1] Fondazione Eni Enrico Mattei - Andrea.Ghermandi@Feem.It

Abstract
This study investigates the economic value of recreational activities in European coastal ecosystems and the potential impact of climate change thereupon. The current values are estimated based on a meta-analysis of 315 value observations from 79 independent studies. Values are found to be significantly affected by characteristics of the valuation study, site-specific characteristics and context characteristics such as biodiversity richness and geoclimatic variables. Benefit transfer techniques are used to scale up values and assess the recreational benefits of coastal ecosystems in 14 European countries. Both the highest individual and aggregated willingness to pay for coastal recreation is found in Mediterranean countries. The impact of climate change on such values under the conditions defined by the four IPCC scenarios is assessed.
Keywords: Biodiversity, Coastal Systems, Economic valuation, Ecosystem services

For the purpose of this study, a large data set of non-market valuations of recreational activities in coastal ecosystems was constructed. In total, 320 primary valuation studies were retrieved and investigated. Of all studies, 79 were found to contain sufficient information for the meta-analysis. The total number of observations in the data set is 315.

The average willingness to pay (WTP) per person per year for recreational activities in the valued sites is estimated by means of meta-analysis. The explanatory variables include valuation study characteristics (e.g., valuation method, welfare measure), site characteristics (e.g., ecosystem type, type of ecosystem service provided) and context characteristics (e.g., GPD per capita, population density, richness in biodiversity, and temperature). Values were standardised to 2003 US$ per person per year.

The results of the meta-regression show that the coefficients of most explanatory variables are statistically significant and with the expected sign. Recreational fishing produces higher individual values than non-consumptive recreational activities. Income effects and population density effects are identified. Values are significantly affected by richness and threats to biodiversity and are positively correlated with temperature. The explanatory value of the model is reasonably high (adj. $R^2 = 0.47$).

Benefit transfer techniques are used to scale up the values estimated with the meta-regression and assess the average individual WTP and aggregated WTP for coastal recreational activities in 13 European countries during the baseline year 2003. Table 2 presents the mean baseline values of WTP per person per year and the aggregated values of coastal recreational activities in the 13 European countries investigated. The highest individual and aggregated values are found in Mediterranean countries such as Italy, Spain and Greece.

The effect of climate change on the recreational values of coastal ecosystems in Europe is investigated based on the storylines of the four IPCC scenario families A1, A2, B1 and B2. The effect of climate change is introduced in the meta-regression model through changes in the values of the context variables and in the total number of tourist arrivals per year. The analysis of the results shows that coastal recreational activities in Mediterranean and Scandinavian countries have the highest potential to benefit from economically oriented policies such as those described in IPCC scenarios A1 and A2. Central and Northern European countries would similarly benefit in terms of overall social welfare from coastal recreational activities from conditions as in scenario A1 and A2, though to a lesser extent. Figure 1 presents as example the comparison of the estimates for scenarios A1 and A2 across individual countries.

References
1 - Bigano, A., Hamilton, J.M., & Tol, R.S.J., 2007. The impact of climate change on domestic and international tourism: A simulation study. *Integrated Assessment Journal*, 7(1), 25-49.

CLIMATE CHANGE IMPACTS ON CLAM DISTRIBUTION IN VENICE LAGOON: A MODELLING APPROACH.

Michol Ghezzo [1]*, Silvia Silvestri [2], Michele Pellizzato [3] and Georg Umgiesser [1]
[1] National Research Council (CNR) - Institute of Marine Sciences (ISMAR) - michol.ghezzo@ve.ismar.cnr.it
[2] UNEP World Conservation Monitoring Centre
[3] Agri.Te.Co

Abstract
Climate change impacts on growth and settlement of larvae of the clam *Tapes philippinarum* in Venice lagoon have been analyzed using a lagrangian larval growth and settlement model. The model has been coupled to a hydrodynamic-transport model, calibrated by the comparison with experimental data, and run according with different climate changes scenarios on 2030. The two scenarios were: i) increase of temperature, ii) increase of temperature combined with sea level rise. Our results show that an increase in temperature without an increase in sea level displays the worse impacts on the settlement of larval stages in the whole lagoon. Both scenarios implicate a considerable change in settlement distribution in different areas employed in fishing and seed harvesting activities.
Keywords: Fisheries, Global Change, Models, Larvae, Lagoons

Introduction
The Venice lagoon is the biggest lagoon in the Mediterranean Sea, characterised by shallow water areas, complex bathymetries and morphological forms. One of the most profitable activities practised in Venice lagoon is clam fishing. Due to management issues, the activity, initially allowed on the whole basin, is now taking place in limited areas of the lagoon, assigned to fishermen by a local government body through 'concessions'. While 'concessions' are employed for the clam culture, other areas are used as source of seed. The goal of this study was to analyse the dynamics of growth and settlement of Tapes philippinarum clams at the juvenile planktonic and spat stage. The adult organisms may growth in an area far from the area where they have been generated, and this factor becomes important in order to predict the position of the 'concession' in the future. In particular, we analysed the dynamics of growth and settlement under two scenarios of climate change trough a lagrangian growth-settlement model coupled with a hydrodynamic-transport model in order to reproduce dispersion, growth and settlement of clam larvae.

Methods
SHYFEM is a hydrodynamic finite element model, which can simulate the circulation and the transport of the water masses and the spatial and temporal evolution of water temperature in the lagoon [1]. The model is able to represent both eulerian and lagrangian transport. This last has been used to calculate the trajectories of lagrangian particles that represent a pool of larval organisms. Each particle is characterised by length, weight, age, settlement state and larvae survival, assumed to be dependent on water temperature. The model has been applied on a bi-dimensional scale on the whole lagoon basin. In order to calibrate each module of the model and to define a reference situation, we have simulated the year 2005 under realistic forcing. Each larva has initial length of 60 micrometers. All particles are transported across the basin and increase their length in function of the local water temperature. When the larvae have a length of about 220 microm they settle on the sediment. When the lagrangian simulation starts the initial particle distribution reflects the distribution of the most productive areas in the lagoon [2]. We assume that a new emission of first stage larval organisms takes place every 90 days in the same initial areas (next generation) and inserts in the lagoon one million of new particles. Two climate change scenarios have been considered according with trends estimated for southern Europe: i) increase of temperature of 0.8°C (T08), ii) increase of temperature and sea level of 0.1 m (L10T08).

Results
The hydrodynamic model has been calibrated with several water level and water temperature measurements. A comparison between experimental data on larval length and weight and simulated data has been carried out in order to verify the functional form employed to simulate the growth and the temperature response from a larval organism.
The comparison between the spatial distribution of the modelled density of settled organisms and the distribution of the most productive areas used to the fishing activity or for the seed harvesting activity indicates that, from a qualitative point of view, the model is able to reproduce the main pattern of distribution. To give a quantitative estimate, three sampling stations have been considered in the inner central part of the lagoon in the year 2005. The comparison between measured and modelled density of individuals per square meter in the areas close to the sampling points indicates that in one case the model can reproduce the order of the measurements, in two cases the model overestimates the data of one order of magnitude. The explanation of this difference is that the quality of sediments has an effect on the settled organisms survival. For this reason we applied 'a posteriori' a corrective factor calculated on the basis of the composition of the sediment in the lagoon. To evaluate the effect of the climate changes on settlement we compared the organisms (particles) successfully settled in the lagoon before the autumnal emission, in the reference simulation and in the scenario simulations. The comparison of the percentage of the successfully settled organisms calculated on the whole lagoon area indicates the T08 scenario as the worst combination, involving a decrease of 1.7% of the successfully settled organisms, whereas in the T08L10 the decrease is only 0.5 %. The number of organisms per square meter that colonises the "concessions" and the seed harvesting areas has been used to evaluate the changes in suitability of each area as consequence of climate changes. Three areas used for the 'concessions' are actually the most productive, but they reduce their suitability in both scenarios. At the same time an increase of the number of settled organisms can be found in a qualified area and other areas, not suitable at present. This effect is evident in the T08L10 scenario. With respect to the seed harvesting zone, the most important area shows a decrease of settled organisms in both scenarios in particular in T08.

Conclusions
We developed a tool that is able to reproduce the dynamics of growth, dispersion and settlement of clam in Venice lagoon. The results of our simulation show that climate changes should negatively affect clam settlement in the Venice lagoon, in particular, the actual level of the sea together with an increase in temperature may have the major negative effects. Furthermore, the impact will not be homogeneous across the lagoon. These results suggest that our numerical tool can be successfully employed in support to the decision regards the lagoon and the fishery management.

References
1 - Umgiesser, G., Canu, D., Cucco, A., Solidoro, C., 2004 A finite element model for the Venice Lagoon. Development, set up, calibration and validation. *Jour. Of Mar. Sys., 51*: 123-145
2 - Torricelli P., Boatto V., Franzoi P., Pellizzato M., Silvestri S. 2009 Piano per la gestione delle risorse alieutiche delle lagune della Provincia di Venezia. Provincia di Venezia, Arti Grafiche Zoppelli Dosson di Casier (TV), pp203

SOCIO-ECONOMIC IMPACTS OF BIODIVERSITY LOSS IN VENICE LAGOON AS RESULT OF CLIMATE CHANGE

Michol Ghezzo [1]*, Michele Pellizzato [1], Silvia Silvestri [2] and Georg Umgiesser [3]
[1] Agri.Te.Co. - michol.ghezzo@ve.ismar.cnr.it
[2] National Research Council (CNR) - Institute of Marine Sciences (ISMAR)
[3] UNEP-Word Conservation Monitoring Centre

Abstract
Rapid global warming can affect an ecosystem's ability to adapt naturally. The potential impacts of climate changes on the clam fishery in the Venice lagoon have been analysed according to two different scenarios by 2030. Biological and socio-economic consequences of changes in population dynamics and species distribution have been evaluated. Both hypotheses of change of sea level rise and surface temperature have shown that the natural capital will be negatively affected and that the impact will not be homogeneous across the whole lagoon.
Keywords: Lagoons, Economic valuation, Coastal Management, Bivalves

With about 800 fishermen and a generated income of about 80 million euros, the Manila clam (*Tapes philippinarum*) fishery is one of the most profitable activities in the Venice lagoon [1].
Due to management issues, the activity, initially allowed on the whole basin, is now taking place in limited areas of the lagoon, assigned to fishermen from a local government body and called 'concessions'. While 'concessions' are employed for clam culture, other areas are specifically used as a source of seed.
The process of identification and assignment of the concession and areas for seed harvesting is articulated and involves numerous management organisms [2].
According to the last Plan for the management of fish resources [2] 3000 ha of surface of the Venice lagoon are designated to clam fishing. This area has been estimated to guarantee the sustainability of the fishery, but only 2000 ha of this surface area are productive.
There is the need to identify the areas that can guarantee the socio-economic stability of the activity. This process is becoming challenging since the adult organisms may grow in an area far from the area where they have been generated.
The knowledge of the possible distribution of clam biomass on the lagoon basin in terms of density and dispersion can support local government and management bodies involved in decisions dealing with the choice of the extension and position of 'concessions' within the basin as well as the assignment of these areas to the fishermen.
Rapid global warming can affect can affect an ecosystems ability to adapt naturally. The lagoon ecosystems are particularly sensitive to change of climatic conditions due to the shallowness and the low volume of water in relation to the surface area [3].
An integrated bio-economic model has been developed according to the valuation framework showed in the figure 1, in order to assess the socio-economic consequences of climate change impacts on biodiversity loss with respect to the Manila clam (*Tapes philippinarum*).
In particular, we analysed the dynamics of growth and settlement under two scenarios of climate change: i) increase of temperature (T08), ii) increase of temperature combined with a sea level rise of 10cm (T08L10).

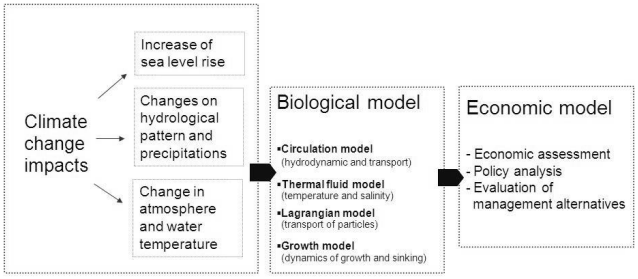


Fig. 1. Valuation framework

The impacts have been analysed through a 'biological model' that results from combining a lagrangian growth-settlement model with an hydrodynamic model (see fig. 1).
The value of each area has been determined by taking into account the outputs from the 'biological model' in terms of number of organisms per square meter that will reach the market size. Bivalves reach the market size, L_0, when their weight is equal to 12.5 g.
By taking into account the final number of organisms per square meter, N_0, their size, L_0 and a market price about 4 euros per kilogram, it is possible to estimate the revenue of the 'concessions'.
The revenue of each 'concession' in one year is equal to:

$$V_i\ (\Delta t, t_0, L_0, N_0) = \sum p \times Hi$$

Where i is the concession, p is the price per kilogram and H is the total biomass of a i 'concession'.
The net income is equal to the income that a 'concession' generates after subtracting costs and expenses from the total revenue.
Our results show that climate changes would negatively affect clam biomass in the Venice lagoon in both scenarios. The impact would not be homogeneous across the lagoon and taking into account different hypothesised sea level rise scenarios, we found that the actual sea level, combined with an increase in temperature, would have major implications. There are areas in which the settlement process would be particularly difficult and areas that would become more suitable for fisheries. By keeping the actual asset of areas in the lagoon, and maintaining the same level of income, equal to about 40.700 euros per year, the number of fishermen would have to decrease by about 200 in the T08L10 scenario and 300 in the T08. If we maintain the same number of people employed in this sector, it would no longer be possible to ensure the same level of income: the income would be reduced in scenario T08 by about 40% and in scenario T08L10 by about 30%. The loss of biodiversity will increase the current level of social tension. It becomes important to promote aquaculture, to protect the nursery areas and to experiment practice of culture with the support of tools as the bio-economic model we developed.

References
1 - Silvestri S., Pellizzato M., Boatto V., 2006. Fishing across the Centuries: What Prospects for the Venice Lagoon? FEEM–Working Paper n. 126.2006, serie SIEV – Sustainability Indicators and Environmental Valuation, Milano, Italy.
2 - Torricelli P., Boatto V., Franzoi P., Pellizzato M., Silvestri S. 2009. Piano per la gestione delle risorse alieutiche delle lagune della Provincia di Venezia. Provincia di Venezia, Arti Grafiche Zoppelli Dosson di Casier (TV), 203 pp.
3 - European Commission, 2005. Climate change and the European Water Dimension. A report to the European water Directors, 253 p.

HEALING MUD FROM SECOVLJE SALTPANS

Neli Glavaš [1]* and Nives Kovac [1]
[1] National Institute of Biology, ljubljana , 1000, Slovenia - glavas@mbss.org

Abstract
The Secovlje saltpans are the northernmost in the Adriatic Sea. Salt is recovered from sea water by solar evaporation and during this process two side products are produced - salt pan mud and brine, both of which have healing effects. Due to its balneological features, healing mud (peloid) is used to threat various diseases and to improve general health and well-being. In order to determine the composition of the mud to be used for pelotherapy different chemical and mineralogical analysis were performed.
Keywords: Adriatic Sea, Coastal Systems, Chemical Analysis

Introduction
The Secovlje saltpans are the northernmost in the Adriatic Sea and one of the few in the Mediterranean where salt is still produced in the traditional way. Salt is recovered from sea water by solar evaporation and during this process twoside products are produced - salt pan mud and brine, both of which have healing effects. Due to its balneological features, healing mud (peloid) is used to threat various diseases and to improve general health and well-being. The mechanisms responsible for these therapeutic features are generally considered to be associated with physical/chemical and thermal effects of the mud [1,2].

Materials and methods
Mud samples were taken on 8th January 2009 at five different sites (M1, B2, D1, L1, P2) in the area of the Secovlje saltpans. The samples were freeze-dried and grounded to a fine powder for analysis. FT-IR spectra were obtained on homogenized samples using a Perkin-Elmer Spectrum One spectrometer. The organic carbon (OC) and total nitrogen (TN) contents were determined with a Carlo Erba model 1108 elemental analyzer. The carbohydrate content was determined spectrophotometrically after Dubois [3], while the proteint content was determined using the Bradford reagent [4]. The mineral composition of the muds was determined bx X-ray powder diffraction (XRD).

Results and discussion
In order to determine the composition of the mud to be used for pelotherapy chemical and mineralogical analysis were performed on samples from five different sites in the area of the Secovlje Salina. Three samples were taken from the crystallizing salt basins (P2, L1, B2), where the mud is exposed to higher water salinity, while the samples D1 and M1 were collected on the river Drnica and channel Curto, which are used for water supply to the saltpans. Organic matter content (Table 1) was overall rather low (0,8-2,3 wt.%), with the highest value at site M1. The values of carbohydrate and protein content were more even, with higher values for samples from the crystallizing salt basins.

Tab. 1. Organic carbon (OC), total nitrogen (TN), carbohydrate (CHO) and proteins (PRT) content.of mud samples from sites M1, L1, D1, P2 and B2.

sample	OC	TN	CHO	PRT
	(%)	(%)	(mg/g)	(mg/g)
M1	2,3	0,1	6,2	3,5
P2	1,4	0,2	6,6	0,1
D1	0,8	0,1	3,4	-
L1	1,2	0,1	3,1	0,5
B2	1,0	0,1	6,5	0,1

The FT-IR spectra (Figure 1) of the mud from all five sites revealed carbonates (2513, 1795, 1420-1450, 876 and 713 cm^{-1}), silicates (1870, 1160, 1020, 799, 780, 695 and 530 cm^{-1}) and clay minerals (3625 cm^{-1}) as the major inorganic components. The organic carbon is confirmed by peaks at 3000-2800 cm^{-1} (CH_2 and CH_3 groups), 1641 cm^{-1} (Amide I) and 1150-1000 cm^{-1} (carbohydrates). Mineralogical analysis confirmed calcite, quartz, halite, muscovite, manganium oxide and clay minerals as the major components.

The database from this study will provide essential data for establishment of normative regulations (standard criteria) and thermal mud production.

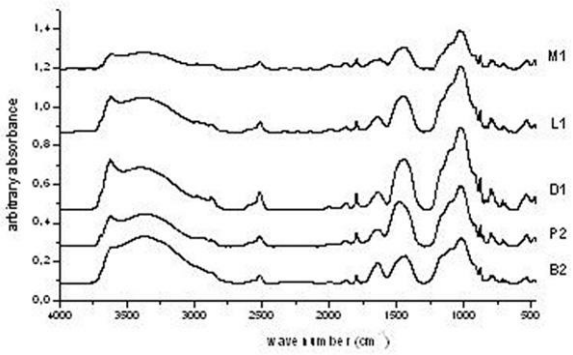


Fig. 1. FT-IR spectra of samples from sites M1, L1, D1, P2 and B2.

References
1 - Veniale F., Bettero A., Jobstraibizer P.G., Setti M., 2007. Thermal muds: Perspectives of innovations. *Appl. Clay Sci*., 36: 141-147.
2 - Miko S., Koch G., Mesic S., Šparica-Miko M., Šparica M., Cepelak R., Bacani A., Vreca P., Dolenec T., Bergant S., 2008. Anthropogenic influence on trace element geochemistry of healing mud (peloid) from Makirina Cove (Croatia). *Environ. Geol*., 55: 517-537.
3 - Dubois M., Gilles K..A., Hamilton J.K., Reber P.A., Smith F., 1956. Colorimetric method of determination of sugars and related substances. *Anal. Chem*., 28: 350-356.
4 - Bradford M.M. 1976. A rapid and sensitive method for quantitation of microgram quantities of protein utilizing the principle of protein-dye-binding. *Anal. Biochem*., 72: 248-254.

ASSESSMENT OF THE ECOLOGICAL STATUS OF MEDITERRANEAN FRENCH COASTAL WATERS USING THE *POSIDONIA OCEANICA* RAPID EASY INDEX: PREI

S. Gobert [1]*, S. Sartoretto [2], V. Rico-raimondino [3], B. Andral [2], A. Chery [4], P. Lejeune [4] and P. Boissery [5]
[1] University of lLiege - Sylvie.gobert@ulg.ac.be
[2] IFREMER
[3] Région Provence-Alpes-Côte d'Azur
[4] STARESO
[5] Agence de l'Eau Rhône-Méditerranée-Corse

Abstract
The PREI (*Posidonia oceanica* Rapid Easy Index) is a method used to assess the ecological status of seawater along Mediterranean French coasts. It was drawn up according to the requirements of the Water Framework Directive (WFD 2000/60/EC) and was tested on 42 stations in PACA (Provence-Alpes-Côtes d'Azur) and Corsica. The PREI is based on five metrics: shoot density, shoot leaf surface area, E/L ratio (Epiphytic biomass/leaf biomass), depth of lower limit, and type of this lower limit. The 42 studied stations were classified in the first four levels of status: high, good, moderate and poor. The PREI values ranged between 0.280 and 0.847; this classification is in accordance with our field knowledge and with our knowledge of the literature. The PREI was validated regarding human pressure levels (r^2= 0.74).
Keywords: Posidonia, Monitoring, Coastal Waters, Phanerogams, Biometrics

Introduction The European Union has launched a new strategy to conserve and recover the ecological quality of the marine environment. In order to attain this objective, the Water Framework Directive (WFD) has established the basis of policies for the monitoring, protection and enhancement of the status of aquatic systems in the Member States. The main goal of the WFD is to achieve (or maintain at least) a "good water status" for all the European waters by 2015. To this end, this directive defines the concept of ecological status as the quality of the structure and functioning of ecosystems associated with homogenous water bodies. The evaluation of the status of each water body is based on the use of some organisms or groups of organisms sensitive to anthropogenic pressures: biological quality elements (BQEs). Phytoplankton, macroalgae, angiosperms and benthic fauna are the BQEs to be considered. According to the WFD, biological variables indicative of the status of these BQEs should be used for evaluation and monitoring purposes. On the basis of previous work on the bioindicating of water global quality by *Posidonia oceanica*, this species was chosen for the Mediterranean area as the angiosperm BQE [1]. As permitted by the WFD, each member state, involved in this BQE, can define its own method to evaluate the state of the *Posidonia oceanica* meadow. We describe the PREI (*Posidonia oceanica* Rapid Easy Index) method used in French coastal regions to evaluate the ecological status of water bodies in the Mediterranean Sea following WFD requirements.

Methodology We calculated the PREI with five metrics measured in *P.oceanica* meadows to define the ecological status of French Coastal Waters according to the WFD recommendations: shoot density, shoot surface, E/L (ratio between epiphytic biomass and leave biomass) measured on shoots sampled at the same depth; depth of the lower limit and type of this limit (regressive, progressive or stable). These metrics were selected because they provide pertinent information on the vitality of the meadow (at the individual and population level) for a wide spectrum of disturbance (water transparency, nutrient concentrations and eutrophization, sedimentary dynamics, grazing pressure…) regularly described in the Mediterranean Sea [2]. As such, they constitute unequivocal indicators of *Posidonia oceanica*. They are also easy to obtain with a good cost–efficiency ratio and low technological investment. According to the WFD, the classification of ecological status is based on the deviation of the status of the BQE from its potential status under pristine conditions (reference conditions: RC). This ecological status is expressed using a scale going from 1 (RC) to 0 (worst conditions where the BQE is badly affected or missing). The ratio between the status of a given BQE noted in a station and its status in the reference conditions is called the Ecological Quality Ratio (EQR). To calculate this EQR, a definition of RC has to be made. RC describe the characteristics in undisturbed conditions. On this basis, considering that no pristine conditions could be found in the studied area, we postulated RC as a "theoric optimal site", corresponding to the best values of each metric noted in the field. We defined EQR' as an index integrating the averaging of the chosen individual metrics: EQR'= (N density + N leaf surface area + N (E/L) +N lower limit)/3.5 with:- N density = value measured-0/reference value-0; - N leaf surface area = value measured-0/reference value-0; 0 being considered as the worst value for the density and for the leaf surface area. - N (E/L) = [1- (E/L)] ×0.5; - N lower limit = (value measured-17)/ (reference value -17), 17 m being considered as the worst lower limit for *Posidonia* meadows. N' = depth noted on the field + λ, where λ = 0 (stable limit), λ = 3 (progressive limit) or λ = -3 (regressive limit). We arbitrarily assigned an EQR value of 0.100 for the "bad" status boundary; the other EQR boundaries were obtained by dividing the remaining scale (from 0.100 to 1) into four categories of equal amplitude: "High, Good, Moderate and Poor status" [3]. Therefore, where *P. oceanica* existed, the EQR was computed as follows: EQR = (EQR' + 0.11)/(1 + 0.10).

Application of the method to the French Coast The sampling was performed at a 15 m depth in April (2007) to prevent the masking effects of depth and seasonal variability . At each station, shoot density, depth and type of lower limit were noted *in situ* by a scuba diver. Twenty shoots of *P. oceanica* were collected for the laboratory measurements (biometry and E/L). The 42 studied stations were classified in the first four levels of status: high, good, moderate and poor. The PREI values ranged between 0.280 and 0.847. Two meadows (8%) received the status of poor in PACA (Corbière and Villefranches); 16% and 22% were qualified as moderate, 62% and 67% as good, 13% and 11% as high both in the PACA area and along the coast of Corsica. The mean PREI EQR in PACA was slightly lower than along the coast of Corsica (0.609 and 0.635 respectively).

In order to verify the robustness of our PREI, we calculated an anthropization index. The anthropization index was defined as the sum of 7 impact factors affecting the seawater quality and /or biotope quality: fish farming, industrial development, agriculture, tourism, fishing, commercial ports and urbanization. Each impact factor was classified from 0 (no impact) to 5 (dramatic effect on the meadow). The quality of seawater expressed by our anthropization index was negatively correlated with the PREI (r^2=0.74). Our index is a destructive technique, requiring scuba divers, using shoot density, the most adopted standardized descriptor (Montefalcone, 2009). All stations were sampled during a short period (10 days), which avoided seasonality effects. The PREI is both cost effective and easily applied. It requires scuba divers working on random punctual stations (15 m depth) and on positioned stations (depth limit). It is a reliable approach for estimating the state of *P.oceanica* meadows and the ecological status of seawater.

References
1 - Med-GIG., 2007. WFD Intercalibration technical report for coastal and transitional waters in the Mediterranean ecoregion. In: WFD Intercalibration technical report – Part 3: Coastal and transitional waters. Available from: http://circa.europa.eu/Public/irc/jrc/jrc_eewai/library?l=/intercalibration_2&vm=detailed&sb=Title

2 - Pergent-Martini C., Leoni V.,Pasqualini V. Ardizzone G.D. Balestri E., Bedini R. Belluscio A. Belsher T. Borg J. Boudouresque C.F. Boumaza S. Bouquegneau J.M. Buia M.C. Calvo S. Cebrian J. Charbonnel E. Cinelli F. Cossu A. Di Maida G. Dural B. Francour P. Gobert S. Lepoint G. Meinesz A. Molenaar H. Mansour H.M. Panayotidis P. Peirano A. Pergent G. Piazzi L. Pirrota M. Relini G. Romero J. Sanchez-Lizaso J.L. Semroud R.Shembri P. Shili A. Tomasello A. and Velimirov B., 2005. Descriptors of *Posidonia oceanica* meadows: use and application. *Ecol. Indic*., 5: 213-230.

3 - Romero, J., Martinez-Crego B. Alcoverro,T. and Perez M., 2007. A multivariate index based on the seagrass *Podidonia oceanica* (POMI) to assess ecological status of coastal waters under the Water Framework Directive (WFD). *Mar. Pollut. Bul*. 55: 196-204.

DISTRIBUTION ET ABONDANCE DU ZOOPLANCTON DE LA COTE NORD DE LA VILLE DE SFAX (TUNISIE): COMPARAISON DE DEUX METHODES D ECHANTILLONNAGE

W. Guermazi [1]*, A. Rekik [1], Z. Drira [1], J. Elloumi [1], A. Bouaïn [1] and H. Ayadi [1]
[1] Université de Sfax, Faculté des sciences de Sfax. Département des sciences de la vie, 3000, Tunisie - wassim016@yahoo.fr

Abstract
La modalité d'échantillonnage agit sur l'abondance relative des différentes classes et espèces de copépodes (P<0,001). Les espèces de copépodes qui échappent à l'échantillonnage par la bouteille fermante sont plus élevées que celles qui ne sont pas récoltées par le filet à plancton. Par contre, les deux techniques d'échantillonnage ne semblent pas affecter la densité du zooplancton total (P>0,05).
Keywords: Coastal Systems, Zooplankton , Sampling Methods, Gulf Of Gabes

Introduction
Les méthodes de collecte de données sont, depuis longtemps, considérées comme un facteur important pour élucider la dynamique des écosystèmes marins [1]. L'estimation de la densité et de la diversité du zooplancton a été réalisée par diverses techniques d'échantillonnage [2]. Dans cette étude, deux techniques d'échantillonnage du zooplancton, par le filet à plancton et la bouteille fermante, ont été testées au niveau de 18 stations réparties sur 6 transects le long de la côte nord de la ville de Sfax. L'échantillonnage du zooplancton a été effectué au niveau de 3 stations dans chaque transect pendant le mois de juillet 2007.

Résultats et discussions
14 classes ont été répertoriées au niveau de 18 stations avec une nette dominance des copépodes qui est de l'ordre de 61,40 % pour les échantillons récoltés par le filet à plancton (Figure 1). Par contre, les copépodes contribuent seulement à 43,36 % dans les échantillons récoltés par la bouteille fermante. Les résultats d'ANOVA complété par le test post-hoc Duncan sur les densités des copépodes montrent une différence hautement significative entre les deux méthodes employées (F= 4,01; d.d.l = 89; P< 0,001). Les abondances relatives des nauplii, des copépodites et des adultes, obtenues par les deux techniques d'échantillonnage, sont similaires, de l'ordre de 60, 23 et 17 %, respectivement. Toutefois, l'analyse statistique montre des différences hautement significatives (ANOVA-Duncan, P<0,001). Les cyclopoïdes dominent largement avec une abondance relative significative (F = 25,32 ; d.d.l = 35 ; p<0,0001) de l'ordre de 75,78 et 87,73 % enregistrées respectivement pour les échantillons récoltés par le filet et la bouteille fermante. L'abondance des harpacticoïdes estimés par le filet et la bouteille diffère significativement (p>0,001) et est environ de 12,63 et 6,55 %, respectivement. Les calanoïdes sont moins abondants que les cyclopoïdes et les harpacticoïdes. L'abondance est de l'ordre de 11,38 et 5,64 %, enregistré respectivement pour les échantillons récoltés par filet et bouteille fermante. Les poecilostomatoïdes sont présents accidentellement au niveau de la zone d'étude (< 0,21%) (Figure 1). Pour les échantillons prélevés par le filet, un total de 15 espèces réparties en 12 familles a été répertorié au niveau de la zone prospectée (Tableau 1). La contribution des Oithonidae dans le nombre total des copépodes varie entre 54,89 et 80,46 %.

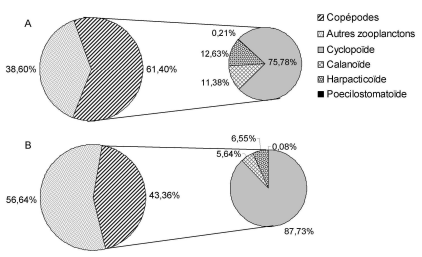


Fig. 1. Abondances relatives des copépodes et des différentes classes enregistrées par le filet à plancton (A) et la bouteille fermante (B)

La contribution des autres familles apparaît faible par rapport à la famille des Oithonidae. En effet, la famille des Tachydiidae contribue à 10,05 %, la famille des Acartiidae représente 6,89 %, la famille des Stephidae 4,12 %, la famille des Tisbidae 1,64 % et les autres familles (Ectinosomidae, Paracalanidae, Centropagidae, Temoridae, Clytemnestridae, Corycaeidae et Oncaeidae) sont présentes en faible abondance. Un total de 11 espèces réparties en 8 familles ont été répertoriés au niveau de la zone prospectée quand l'échantillonnage est fait par la bouteille fermante (Tableau 1). L'abondance des Oithonidae, au niveau des différentes stations étudiées de la côte nord de Sfax, domine largement, entre 64,28 et 99,62 %. Cependant, les familles des Clytemnestridae, Acartiidae, Tachydiidae et Stephidae présentent respectivement 3,96, 3,23, 2,59 et 2,28 %. L'abondance des autres familles (Ectinosomidae, Temoridae et Oncaeidae) est peu importante.

Tab. 1. Les espèces de copépodes inventoriées dans la zone d'étude par les deux méthodes d'échantillonnage

Classes de copépodes	Filet à plancton	bouteille fermante
Cyclopoïdes		
Oithona nana	×	×
Oithona similis	×	×
Oithona helgolandica	×	0
Calanoïdes		
Acartia clausi	×	×
Acartia italica	0	×
Acartia discaudata	0	×
Paracartia latisetosa	×	×
Paracartia grani	×	×
Centropages kroyeri	×	0
Centropages typicus	×	0
Paracalanus parvus	×	0
Stéphos marsalensis	×	×
Temora longicornis	0	×
Harpacticoïdes		
Clytemnestra scutellata	×	×
Microsetella rosea	×	0
Microsetella norvegica	×	0
Euterpina acutifrans	×	×
Tisbe battagliai	×	0
Poecilostomatoïdes		
Corycaeus clausi	×	0
Oncaea conifera	×	×
Oncaea mediterranea	×	0

× : présents ; 0 : absents

Cette étude montre une nette dominance de l'espèce *Oithona nana* avec 72,84 % au niveau des échantillons prélevés par le filet. Toutefois, l'espèce *Oithona similis* domine les échantillons récoltés par la bouteille fermante avec 66.17 %. Les autres zooplanctons (Larves de cirrhipède, Larves véligères de gastéropode, Ostracodes, Bivalves, Annélides polychètes, Méduses, Tintinnides, Euphausiacés, Zoés, Amphipodes, Cladocères, Nématodes et Appendiculaires) ont été répertoriés au niveau de toutes les stations, mais avec une abondance plus importante pour les échantillons prélevés par la bouteille fermante (56,64 % du zooplancton total) (Figure 1). L'ANOVA n'a pas révélé de différence significative de densité entre les deux techniques d'échantillonnage (p>0,05). Cette étude montre que la technique d'échantillonnage affecte l'estimation de l'abondance et la distribution des copépodes, ce qui corrobore les résultats de Youngbluth [3].

References
1 - Sherman K., 1980. MARMAP, a fisheries ecosystem study in the northwest Atlantic: fluctuations in ichthyoplankton–zooplankton components and their potential for impact on the system. *In*: Diemer F.P., Vernberg F.J. and Mirkes D.Z. (eds.), Advanced Concepts in Ocean Measurements for Marine Biology. Belle W. Baruch Institute of Marine Biology and Coastal Research, Georgetown, South Carolina, USA.
2 - Broughton E. A. and Lough R. G., 2006. A direct comparison of MOCNESS and Video Plankton Recorder zooplankton abundance estimates: Possible applications for augmenting net sampling with video systems. *Deep-Sea Res. II*, 53: 2789-2807.
3 - Youngbluth M J., 1982. Sampling demersal zooplankton: A comparaison of field collections using three different emergence traps. *J. Eup. Mur. Biol. Ecol*., 61: 111-124.

CARBONIC ANHYDRASE IN MUSSEL *MYTILUS GALLOPROVINCIALIS*: A PRELIMINARY STUDY

Dijana pavicic Hamer [1]* and Bojan Hamer [1]
[1] "Ruder Boškovic" Institute - pavicic@cim.irb.hr

Abstract

We investigated the esterase activity of carbonic anhydrase (CA) on total esterase activity level in mussels sampled from 19 locations along the Croatian coast of Adriatic Sea. The results of total esterase activities in winter were lower than in summer at almost all investigated locations. CA activities determined in gills of mussel sampled in winter ranged from 1.75% to 24.65% of total esterase activity. CA activities in summer samples were practically not detectable. Despite *in vitro* research showed potential application of CA activity in bioassay and biomarker studies for application of CA as a biomarkers of environmental pollution further research are needed.

Keywords: Adriatic Sea, Ecotoxicology, Enzymes, Mollusca, Pollution

INTRODUCTION

Carbonic anhydrase (CA), a ubiquitous enzyme in the bacteria, plant, and animal kingdoms catalyses the reversible hydration of CO_2 to produce H^+ and HCO_3^- using zinc as a cofactor. To date 15 CAs or CA-like proteins have been identified in mammals. In humans, for CAII isozyme, turnover number for CO_2 hydration is the highest known for any enzyme, while for the other isozymes activities are lower in the order CAII > CAIV > CAI > CAIII. There are several CAs which have shown esteraze activity, enzymes known to hydrolyse endogenous substrates, and the majority hydrolyse lipid ester substrates. In *in vitro* conditions, the esterase activity of CA was determined, both in physiological and pathological conditions. Additionally, besides Na,K-ATPase, CA represents a key enzyme involved in the adaptation of marine organisms to environmental conditions [1]. Experimental studies performed on Crustacea gills have shown two main isozymes of CA located in membrane-bound and in cytosolic fractions, functionally similar to mammalian CAIV and CAII [2]. So far no report has dealt with the esterase activity of CA on total esterase activity level in mussel.

MATERIAL AND METHODS

In this study the esterase activity of CA on total esterase activity level was investigated in mussels sampled from 19 locations along the Croatian coast. The gills were the target tissue because the respiratory, ionic transport and pH regulatory enzyme function of CA and it's potential usage as a biomarker of environmental pollution was the main topic. Previously it was suggested the possible application of CA activity inhibition as an *in vitro* bioassay for the detection of heavy metals in pollution monitoring using the mussel *Mytilus galloprovincialis* Lamarck, 1819 [3,4]. Total esterase activity was measured in the cytosolic fraction of gills homogenates by colorimetric end point reaction using p-nitrophenyl acetate as enzyme substrate, and CA activity was estimated by the same enzymatic reaction using acetazolamide as a specific CA inhibitor.

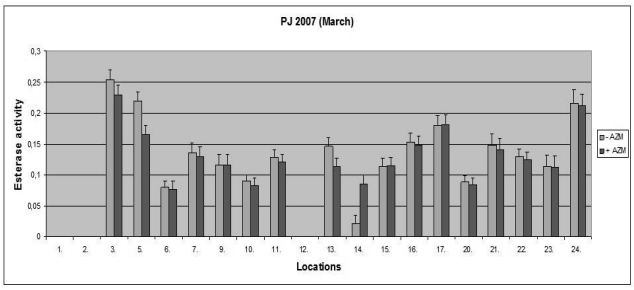


Fig. 1. Total esterase activity in cytosolic fraction of mussel gills: (-AZM) without specific CA inhibitor and (+AZM) with acetazoamide inhibition.

RESULTS

The results of total esterase activities in winter (March; average value 0.137±0.057) were lower then determined for the summer season (August; 0.153±0.036) at almost all investigated locations (Fig. 1). CA activities determined in gills of mussels sampled in winter ranged from 1.75% to 24.65% of total esterase activity. CA activities in summer samples were practically not detectable. This is preliminary research; it is difficult to assume a direct relationship between pollution at investigated sites with determined CA activities, especially in the summer period.

INSTEAD OF CONCLUSIONS

Inspite *in vitro* studies showing clear inhibition of CA activity with heavy metals, for the application of CA as a biomarker of pollution further detailed research on the effects of environmental and physiological factors and different CA isozymes activity using different inhibitors, protein characterization and sequencing are needed. With this paper we report a partial CAII sequence of *M. galloprovincialis* (Fig. 2) which is, according to the NCBI database the first normal one for Mollusca, Bivalvia, besides nacrein, nacrein-like proteins and the novel CA from *Tridacna gigas* with two CA domains.

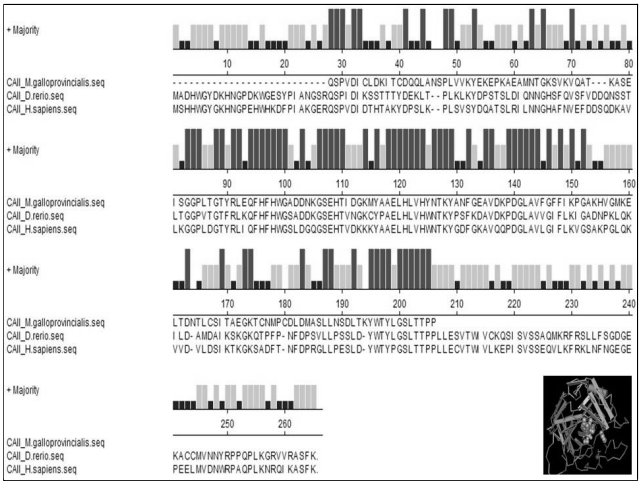


Fig. 2. Alignment of our partial *M. galloprovincialis* cDNA sequence with similar human and fish CAs after NCBI blast.

References

1 - Pavicic-Hamer D., Devescovi M. and Lucu C., 2003. Activation of carbonic anydrase in brachial cavity tissues of lobsters (*H. gammarus*) by dilute seawater exposure. *JEMBE* 287: 79-92.

2 - Henry R.P., 2001. Environmentally mediated carbonic anhydrase induction in the gills of euryhaline crustaceans. *J. Exp. Biol.* 204: 991-1002.

3 - Lionetto M.G., Caricato R., Erroi E., Giordana M.E. and Schettino T., 2006. Potential application of carbonic anhydrase activity in bioassay and biomarker studies. *Chemistry and Ecology* 22: S119-S125.

4 - Gilbert A.L. and Guzman H.M., 2001. Bioindication potential of carbonic anhydrase activity in anemones and corals. *Marine Pollution Bulletin* 42: 742-744.

ON THE USE OF FINITE-DIFFERENCE AND NEURAL-NETWORK MODELS TO EVALUATE THE IMPACT OF THE DIMINUTION OF RAINFALL GROUNDWATER'S OVEREXPLOITATION

A. Hani [1]*, A. Badra [1], D. Larbi [2], E. Carlir [1] And I. Shahrour [1]
[1] Ecole Universtaire Polytechnique De Lille - Ahani59@Yahoo.Fr
[2] Laboratoire De Géologie, Université Badji Mokhtar Annaba, BP 12, 23000 Annaba, Algérie

Abstract
The purpose of this study is to include expert knowledge as one part of the modelling system and thereby offer the chance to create a productive interactive system between expert, mathematical model, ASM ([1]), and artificial neural networks (ANNs). An attempt to determine outflow-influencing parameters in order to simulate spring flow is presented.
Keywords: Models, Behaviour, Algerian Basin

The Bouteldja dune aquifer (NE of Algeria) is fed by rains and streaming water on the sandy argillaceous relieves in the Est. The lateral passage to the gravel of the Bouteldja Plain is marked by numerous bogs that correspond to the piezometric level. These bogs have long been an environment for migratory birds and a natural reserve for many species. However, the continued exploitation of about 30 wells has negatively influenced the hydrodynamic equilibrium of the aquifer and has brought a diminution of spring's capacity ([2], [3]). In this study, we tried by using a hydrodynamic model and the neural network to ascertain the state of the resources and to identify the factors responsible for the decreasing flows of the three principal springs of the area (Bougles, Bourdim and Titteri) by using neural networks. The calibration in the non-steady state allowed for the depletion of the layer storage, related essentially to an overexploitation, and a weak recharge to be taken into account. This hydraulic deficit was represented by a drop of the piezometric surface (Figure 1) that can amount to 30 m, and by a closely corresponding reduction of the areal extent through which groundwater emerges into the surface. This situation had a direct consequence on the surface, on the hydrologic regime of the wet areas, and on the degradation of the water quality of rivers and lakes. The ANNs show that the decrease in flows of the springs is not only due to the unfavourable climatic conditions, but also to the intensive exploitation of the aquifer. These results show that the groundwater reserves are decreasing over time, thus highlighting the need to take some urgent measures to stop this phenomenon.

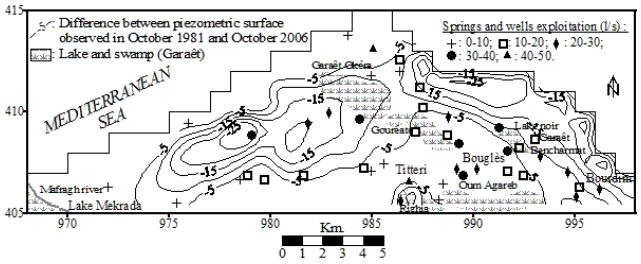


Fig. 1. Drawdown map of the massif of Bouteldja's aquifer (October 1981–October 1994).

References
1 - Kinzelbach, W. and Rausch, R., 1990. Aquifer Simulation Model « ASM ». Documentation, Version 2.0 (July 1990). Intern. Ground Water Modelling Centre, The Netherlands.
2 - Hani A., Lallahem S., Mania J., Djabri L., 2006. On the use of finite-difference and Neural network models to evaluate the impact of underground water overexploitation. *Hydrol. Process.* 20, 4381-4390.
3 - Samraoui B. et de Belair G., 1998. Les zones humides de la Numidie orientale. Bilan des connaissances et perspectives de gestion. Revue Synthèse, pub. de l'université de Annaba (Algérie), n°4, 90p.

SPATIAL DISTRIBUTION OF THE CILIATE COMMUNITY IN THE GULF OF TUNIS (TUNISIA, EASTERN MEDITERRANEAN SEA)

I. Hannachi [1], Z. Drira [1], W. Guermazi [1]*, J. Elloumi [1], M. Belhassen [2], A. Bouaïn [1], L. Aleya [3] and H. Ayadi [1]

[1] Institut National des Sciences et Technologie de la Mer. 2025 Salammbô Tunis, Tunisie

[2] Université de Franche-Comté, Laboratoire de Chrono-Environnement, UMR CNRS 6249, 1, Place Leclerc, 25030 Besançon cedex, France

[3] Université de Sfax, Faculté des sciences. Département des sciences de la vie, UR05ES05, Biodiversité et Ecosystèmes Aquatiques, Sfax, 3000 , Tunisie - wassim016@yahoo.fr

Abstract

The spatial distribution of ciliates was studied in the Gulf of Tunis (NE Tunisia) in August 2006. 17 species belonging to 3 groups were identified. Spirotrichea was the dominant group in the inner (92%) and the outer (94%) shelf. The ciliate density decreased from the coast (mean ± s.d = 108.33 ± 80.10 cells l^{-1}) to the open sea (mean ± s.d = 56.25 ± 47.87 cells l^{-1}) areas. In terms of a vertical occurrence, the ciliate community showed a decrease from the surface to the bottom.

Keywords: Coastal Waters, Open Sea, Deep Waters, Surface Waters, Plankton

Introduction

Studies on marine protozoans have been carried out in the Mediterranean for many years, and their importance in the trophic organization and community structure of pelagic ecosystems has been emphasized [1]. However, studies addressing the distribution of ciliate assemblages in the Gulf of Tunis (NE Tunisia) are totally missing. Therefore, it seems very interesting to study the protozoa community in this area. The present study gives, for the first time, the structure and the spatial distribution of the ciliate community in the Gulf of Tunis.

Material and methods

Sampling was performed in 4 coast-to-offshore stations during a cruise on board the R/V Hannibal in August 2006. Samples were taken at 3 depths (surface, middle of water column and bottom) for stations <100 m deep and at 5 depths (surface, -10 m, -20 m, thermocline and bottom) for stations >100 m deep. In each station, profiles of temperature, salinity, dissolved oxygen and water density were collected with a CTD: SBE 9 equipped with a 12 Niskin bottle rosette sampler. Samples for nutrients were stored at -20°C before analysis with a BRAN and LUE BBE type 3 analyzer. Sub-samples (1L) for ciliates were fixed with acid Lugol solution (2% final concentration) and stored in the dark at low temperature (4°C) until analysis. The different species were quantified with an inverted microscope using 20 ml Utermöhl chambers. The entire surface of the chamber was examined at 40 x magnification.

Results and discussions

Water column profiles showing the range of physico-chemical in the different stations of the two gulfs are summarized in Table 1. During this study, a strong thermocline was detected at the mean depth of 30 m. No significant difference ($P>0.05$) was detected between the coast and the open sea area, in terms of physico-chemical parameters (Table 1).

Tab. 1. Min, max and Mean ± S.D. of physico-chemical parameters in the Gulf of Tunis

	Min	Max	Mean ± s.d
Physical parameters			
Temperature (°C)	13.58	27.34	18.19 ± 5.16
Salinity (p.s.u)	37.17	38.68	37.77 ± 0.44
Sigma-t (Kg m^{-3})	24.46	29.06	27.24 ± 1.63
Dissolved oxygen (mg l^{-1})	4.48	5.74	5.29 ± 0.47
Chemical parameters			
$N\text{-}NO_3^-$ (µmol l^{-1})	0.1	1.21	0.66 ± 0.35
$N\text{-}NO_2^-$ (µmol l^{-1})	0.02	0.63	0.25 ± 0.15
$N\text{-}NH_4^+$ (µmol l^{-1})	0.04	0.99	0.45 ± 0.36
$Si(OH)_4$ (µmol l^{-1})	0.02	1.23	0.32 ± 0.4
$P\text{-}PO_4^{3-}$ (µmol l^{-1})	0.01	0.87	0.28 ± 0.24
T-N (µmol l^{-1})	5.61	10.56	7.18 ± 1.16
T-P (µmol l^{-1})	0.32	1.95	1.02 ± 0.33
N/P ratio	0.92	84.29	14.63 ± 20.98

The N/P ratio (mean ± s.d = 14.63 ± 20.98) was lower than the Redfield ratio (16) suggesting a potential N limitation. During this summer study, 17 different species belonging to 3 groups: Spirotrichea, Oligohymenophorea and Colpodea were identified. In the coastal and the open sea stations, Spirotrichea dominated the ciliate community with 92% and 94%, respectively. In fact, this group was the most abundant in the Gulf of Gabes [1]. Although tintinnids were characterized by a small contribution to the ciliates community [2], in this present study, they contributed 40% of the total ciliates. Among this class, Choreotrichia contributed 80%. The loricates ciliates constitute an important group in the Choreotrichia (91%) and in the total of the ciliates community (40%). The protozoa community marked a decrease from the inshore (mean ± s.d = 108.3 ± 80.1 cells l^{-1}) to the offshore (56.2 ± 47.9 cells l^{-1}). In terms of the vertical distribution, ciliate density showed a maximum in the middle of the water column (150 ± 141.42 cells l^{-1}). However, in stations where the bottom was above 100m, ciliate density showed a decrease from the upper (125 ± 35.35 cells l^{-1}) to the deeper (75 ± 106.1 cells l^{-1}) layer (Fig. 1).

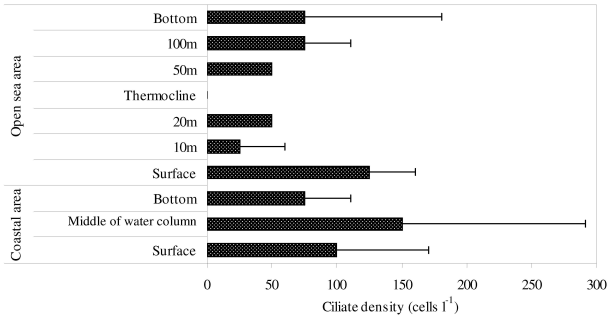


Fig. 1. Vertical distribution of ciliate density in both inshore and offshore stations

This differed from the gulf of Gabes, where ciliate density increased from the surface to the bottom [1]. However, no significant correlation ($P>0.05$) was detected between the physico-chemical parameters and the spatial distribution of the ciliate community.

References

1 - Hannachi I., Drira Z., Bel Hassen M., Hamza A., Ayadi H., Bouain A. and Aleya L., 2009. Abundance and biomass of the ciliate community during a spring cruise in the Gulf of Gabes (East Mediterranean Sea, Tunisia). *Acta Protozool*., 47: 293-305.

2 - Dolan J.R., 2000. Tintinnid ciliate diversity in the Mediterranean Sea: longitudinal patterns related to water column structure late spring-early summer. *Aqua. Microb. Eco*l., 22: 69-78.

FLUVIAL INPUTS AND ISOTOPIC SIGNAL OF ORGANIC MATTER DISCHARGED TO THE NW MEDITERRANEAN

M. Higueras [1], P. Kerhervé [2]*, A. Sanchez vidal [1], C. Liquete [1], A. Calafat [1], M. Canals [1], W. Ludwig [2] and S. Heussner [2]
[1] CEFREM UMR CNRS 5110 - Université de Perpignan, 66860, France - kerherve@univ-perp.fr
[2] GRC Geociències Marines, Univ. Barcelona, 08071, Spain

Abstract
Nine rivers discharging to the NW Mediterranean (Gulf of Lions and Catalan Sea) are currently biweekly/monthly studied to understand their role in the transport of organic matter from the continent to the ocean. Water discharge, total suspended sediment, particulate organic carbon and nitrogen contents and their isotopic ratios will be used to answer to major questions regarding the amount and quality (as a measure of source) of organic matter which is effectively transported from land to sea.
Keywords: Western Mediterranean, River Input, Organic Matter

River systems represent the primary pathway for carbon transport from the terrestrial to the marine environment, and are thus critical in determining the quantity and composition of carbon reaching the continental shelf. In addition, physical processes occurring at the shelf edge are capable of transferring this accumulated organic carbon to the deep sea. Thus, identifying sources and fluxes of carbon and nitrogen to the continental margin is essential to understanding carbon and nitrogen cycling in the overall marine environment.

We have analyzed the temporal variations of water discharge, total suspended sediment, particulate organic carbon (C_{org}) and nitrogen (N) contents and their isotopic ratios ($\partial^{13}C$ and $\partial^{15}N$) from three Catalan rivers (Fluvià, Ter and Tordera) and six French rivers (Têt, Agly, Aude, Orb, Hérault, Rhône) flowing into the Catalan margin and the Gulf of Lion, respectively, in the Western Mediterranean [1].

First results from the 2008-09 period show that the origin of the organic matter carried by the Catalan rivers is mostly waterweeds in the Fluvià River and soil with terrestrial vegetation in the Ter and Tordera rivers. In addition, $\partial^{15}N$ results show that Ter and Tordera rivers undergo anthropogenic inputs of inorganic nitrogen, while the Fluvià River is the less human-impacted. Moreover, alteration of the solid load by artificial dams has been observed to be a significant factor influencing the total suspended sediment in the Ter River.

The French rivers have high Corg and N contents (up to 20% and 5%, respectively). The main feature of this survey concerns the high seasonal variation in the quality of the riverine particulate organic matter excepted for the Rhone River. In summer, the biological production (mainly freshwater phytoplankton) is enhanced in sunlit and calm waters, whereas higher water flows floods discharging material mainly originated from soil erosion characterize winter and spring. The Têt River exhibited atypical $\partial^{13}C$ and $\partial^{15}N$ values that may reflect the large influence of the sewage treatment plant of Perpignan.

Overall, particulate matter samples from these nine rivers are used to characterize the riverine input to the adjacent coastal system and provide information about the fate of the land-sea transported particles and their potential impact on the marine ecosystems.

References
1 - Kerhervé P., Ludwig W., Pischedda L., Jeanty G., Carbonne J. Stable isotopic tracers ($d^{13}C$ and $d^{15}N$) of riverine inputs into the Gulf of Lions: result from a one-year survey. Continental Shelf Research (submitted)

THE IMPACT OF THE CONSTRUCTION AND OPERATION OF LIQUEFIED NATURAL GAS (NLG) TERMINALS ON MERCURY MOBILITY AND REACTIVITY FROM POLLUTED COASTAL SEDIMENTS

M. Horvat [1]*, R. Rajar [2], M. Cetina [2], N. Ogrinc [1] and D. Kocman [1]
[1] Jozef Stefan Institute - milena.horvat@ijs.si
[2] University of Ljubljana, Faculty of Civil and Geodetic Engineering

Abstract
The sediment of the Gulf of Trieste is heavily polluted by mercury (Hg) originating from Hg mining activities in the past. The construction of two gas terminals for LNG is planned in this heavily contaminated site. A simulation based on previously developed models and measurements indicated that due to the enhanced mobility and reactivity of Hg from the sediment, elevated mercury concentrations in fish are expected in the future.
Keywords: Coastal Management, Mercury

Mercury in the Gulf of Trieste is mainly present due to the discharge of the Soca river, which drains the area of the second largest mercury mine in the world, Idrija in Slovenia [1-5]. In 500 years of its operation, the mining activity discharged over 35.000 tons of mercury into the environment. A large quantity of this mercury is buried in the sediment of the Gulf of Trieste. Concentrations of Hg in sediment frequently exceed the limit value of 2 mg/kg. Due to the presence of methylating bacteria, mercury is transformed from inorganic form to monomethylmercury (MeHg) which is the most toxic compound of mercury [3]. Bioaccumulation and biomagnifications of MeHg in biota results in high concentrations of this toxic compounds in edible fish. Therefore, the reduction of MeHg in the environment is one of the primary objectives in remediation of mercury contaminated sites [4].

Based on the state of the art knowledge of mercury cycling the Gulf of Trieste, simulations of resuspension of the bottom sediments during construction and operation of the terminals were made by the 3D numerical model PCFLOW3D[6-9]. The PCFLOW3D is a non-steady state three-dimensional non-linear baroclinic z- coordinate model with hydrostatic approximation. The model was developed at the Faculty of Civil and Geodetic Engineering of the University of Ljubljana and consists of four modules: a hydrodynamic (HD) module, a transport-dispersion (TD) module, a sediment-transport (ST) module and a biogeochemical (BGC) module, in order to simulate the transport and transformations of mercury.

Besides the simulations of hydrodynamics and some basic pollutants, special care was given to the development of the module for the simulation of transport and fate of mercury. Initially, the seasonal (four seasons) hydodynamic of water was simulated based on measurement data of the temperature and salinity (3 D fields), the average seasonal wind directions and velocity, as well as water discharge of Isonco river. Taking the exact geographical position of planned NLGs, mercury concentrations in sediments, seasonal production of MeHg in sediments, the flux of inorganic Hg and MeHg into the water column was calculated. Specifics of seasonal variations in hydrodynamics and in particular biogeochemical cycling of mercury was taken into account. The calculations were mainly concentrated on the changes of MeHg release, which tends to bioaccumulate and biomagnify in food webs. MeHg production vary from season to season. The following relative intensity of MeHg production was taken into account: 2.5 for autumn, 1.5 for winter, 2.5 spring and 6 for summer. This ratios were experimentally determined in previous studies [3,4].

The model simulations showed that the construction of the two terminals would cause a resuspension of 75.000 tons of bottom sediment, and the ships transporting LNG would cause a resuspension of 175.000 tons of sediment per year. Based on the partitioning of mercury between sediment and water during different seasons and rates of mercury transformation from inorganic to organic mercury it was calculated that the highly toxic MeHg in the Gulf water would increase from the present 0.05 ng/L to about 0.09 ng/L and the concentration of MeHg in fish from the present 0.3 to 0.6 mg/kg. This raises a question of safe consumption of fish in the Gulf of Trieste.

Based on the methodology developed simulations of various scenarios were also proposed that would significantly reduce the production of MeHg during installation and operation of NLGs.

References
1 - Covelli S., Faganeli J., Horvat M., Brambati A., 1999. Porewater distribution and benthic flux measurements of mercury and methylmercury in the Gulf of Trieste. *Estuar., coast. shelf sci.*, 48: 415-428.
2 - Faganeli J., Horvat M., Covelli S., Fajon V., Logar M., Lipej L., Cermelj B., 2003. Mercury and methylmercury in the Gulf of Trieste. *Sci. total environ.* 304: 315-326.
3 - Hines M.E. et all., 2000. Mercury Biogeochemistry in the Idrija River, Slovenia from above the Mine into the Gulf of Trieste. *Environ. Res. Sec.A*, 83: 129-139.
4 - Horvat M., Covelli S., Faganeli J., Logar M., Mandic V., Rajar R., Širca A., Žagar D., 1999. Mercury in contaminated coastal environments; a case study: the Gulf of Trieste. *Sci. Total Environ.* 237/238: 43-56.
5 - Rajar, R., Cetina, M., Širca, A., 1997. Hydrodynamic and water quality modelling: a case studies. *Ecol Model.* 101: 209-228.
6 - Rajar R., Žagar D., Cetina M., Akagi H., Yano S., Tomiyasu T., Horvat M. Application of three-dimensional mercury cycling model to coastal seas. *Ecol. model.* 171: 139-155.
7 - Rajar R., Žagar D, Širca A., Horvat M. Three-dimensional modelling of mercury cycling in the Gulf of Trieste. *Sci. total environ.*. 260: 109-123.
8 - Širca A., Rajar R., Harris R.C., Horvat M., 1999. Mercury transport and fate in the Gulf of Trieste (Northern Adriatic)- a two dimensional modelling approach. *Environ. Mod. Soft.* 14: 645-655.
9 - Žagar D., Knap A., Warwick J.J., Rajar R., Horvat M., Cetina M., 2006. Modelling of mercury transport and transformation processes in the Idrijca and Soca river system. *Sci. total environ. 368: 149-163* .

CIRCULATION, HYDROGRAPHY AND PRIMARY PRODUCTION CHARACTERISTICS OF THE SYRIAN MARINE WATERS, NORTHEASTERN MEDITERRANEAN SEA.

Mohammad Hussein [1]*
[1] University of Perpignan - mohammad.hussein@voila.fr

Abstract
This work describes the oceanographical properties of the Syrian marine water on the basis of two cruises performed during Dec.2006 and Mar.2009 using a 19plus CTD. Analysis of hydrological data from the study area reveals the presence of three water masses in each cruise: Land Water of lower salinity on water depths up to 20m during Dec and Mar, Levantine Surface Water with higher salinity only during Dec, Modified Atlantic Water of lower salinity in the bottom layer during Dec and in the surface layer during Mar, and finally Levantine Intermediate Water at the bottom during Mar. Chlorophyll -a concentration measured varied markedly with depth and season, being 0.05±0.01mg.m-3 during Dec and 0.08±0.01mg.m-3 during Mar. The deep Chl-a maxima, of 0.08mg.m-3 during Dec and 0.1mg.m-3 during Mar, were observed between 50-100m.
Keywords: Hydrology, Chlorophyll-a, Levantine Basin

The Syrian marine water is one of the least-known areas of the Eastern Mediterranean sea and much work is needed to cover the gaps. This work describes the oceanographical properties of the Syrian marine water (north-eastern part of the Levantine Sea) on the basis of two hydrographical cruises performed during Dec.2006 and Mar.2009 using a Seabird model 19plus CTD probe. Analysis of hydrological data from the study area reveals the presence of three water masses in each cruise: Land Water of lower salinity on water depths up to 20 m during Dec.2006 and Mar.2009, Levantine Surface Water with higher salinity (39.50-39.75) only during Dec.2006, Modified Atlantic Water of lower salinity (38.89) in the bottom layer during Dec.2006 and in the surface layer during Mar.2009, and finally Levantine Intermediate Water at the bottom during Mar.2009. Stratification was clearer in December compared to March, and cyclones and anticyclones were observed in specific times and locations. Geostrophic velocities, which were found to be directed northward with a maximum of 17 cm/s, revealed that cyclonic eddy (max. 7 cm/s southward at 150 m depth) in the northern area and anticyclonic one (max. 13 cm/s southward at 50 m depth) in the southern area were present. Dissolved oxygen was higher in Mar.2006 (214±4.8 µM) than in Dec.2009 (202±11.5 µM), with the whole water column (down to 300 m depth) being homogenous during Mar.2009, but only the top 125 m, which represent the Levantine Surface Water, were homogenous during Dec.2006 and decreases afterward due to the presence of the Modified Atlantic Water. Chlorophyll-a concentration measured varied markedly with depth and season, being 0.05±0.01 mg.m-3 during Dec.2006 and 0.08±0.01 mg.m-3 during Mar.2009. The deep Chl-a maxima, of 0.08 mg.m-3 during Dec.2006 and 0.1 mg.m-3 during Mar.2009, were observed between 50-100 m water depth. These Chl-a maxima were associated with the cyclonic and anticyclone eddies at 40-75 m and at 80-105 m water depth, respectively. Sea-viewing Wide Field of view Sensor (SeaWiFS) was used to validate the spatial and temporal distribution of chlorophyll-a (Chl-a) concentrations around Latakia (main city of the Syrian coast) during Dec.2006. A significant correlation was found between SeaWiFS and in situ data (r2=0.82). At low Chl-a concentrations (<0.1 mg-3), SeaWiFS estimates were approximately 70% of in situ values, but only 30% at high Chl-a concentrations (>0.1 mg-3). Keywords: Hydrography; Chlorophylls; Dissolved Oxygen; Geostrophic flow.

References
1 - Zodiatis, G., Theodorou, A. and Demetropoulos, A., 1997. Hydrography and circulation south of Cyprus in late summer 1995 and in spring 1996. *Oceanol. Acta*, 21: 447-458.
2 - Vitayz, 1992. The Syrian-Russian joint exploration mission in the Eastern Mediterranean Feb. 12 Mar. 11, 1992.
3 - Filiz, K and Idil, P., 2005. Circulation, hydrographic and nutrient characteristics of the Cilician Basin, Northeaster Mediterranean Sea. *J. of Marine Systems*, 59: 189– 200.
4 - Benkhelil, J., Bayerly, M., Branchoux, S., Courp, T., Gonthier, E., Hübscher, C., Maillard, A., and Tahchi, E., 2005. La branche orientale de l'arc de Chypre. Morphostructure d'une frontière de plaques d'après les résultats de la campagne BLAC (2003). C. R. *Geoscience*, 337: 1075-1083.

CONTENTS OF HEAVY METALS IN COASTAL SURFACE SEDIMENTS FROM MONTENEGRIAN COAST

Danijela Joksimovic [1]* and Slavka Stankovic [1]
[1] Institute of marine biology, P.Box 69, 85330 Kotor, Montenegro, e-mail - djoksimovic@ibmk.org

Abstract
The aim of the present work was to determine the levels of lead, cadmium, arsenic and mercury in coastal surface sediments at three stations located in the „inner shore“ waters Boka Kotor Bay, and at one station located „off shore“ Montenegrian coast, considered as a reference station. The comparision of the results obtained for the „inner shore“ stations with reference station showed that the content of this metals in some station are considerable increased in ratio to reference station.
Keywords: Sediments, Metals

Introduction
Also as other areas on Montenegrin coast, this system (Boka Kotor Bay) is also under a great impact of anthropogenic factors and the activities on the shore. The river weighted by sewage, canalization and industrial waters brings large quantities of pollutants into the sea [1]. The material washed from the shore by large quantities of precipitation in Boka Kotor Bay, together with the stationed industrial objects and hospitals on the very shoreline of the Bay, contribute to the pronounced negative anthropogenic impact on this area [2].

Material and Methods
Samples of bottom sediments were taken from a depht of 15-20 cm using a internal diameter plastic gravity corer. Bottom sediments were characterized by amorphous form, brown-green colours, high hydration and significant organic matter content. The sampling was done in autumn of 2005 and 2006 at 4 stations in the Montenegrian coast (Kotor, Tivat and Herceg Novi in Boka Kotor Bay and Mamula, location at the open sea), Fig.1. Dry sample (abaut 0.3 g) is dissolved with HNO_3+$HCLO_4$+HF (4+1+6). All the samples were examined in laboratory using atomic absorption spectrometer equipped with a deuterium-are background corrector and Perkin Elmer MHS-10 hydride generator were used. Standard holow cathode lamps were used for all elements exept arsenic, for which a Electrodes Discharge (EDLs) lamp was used. Each samples was analyzed in triplicated.

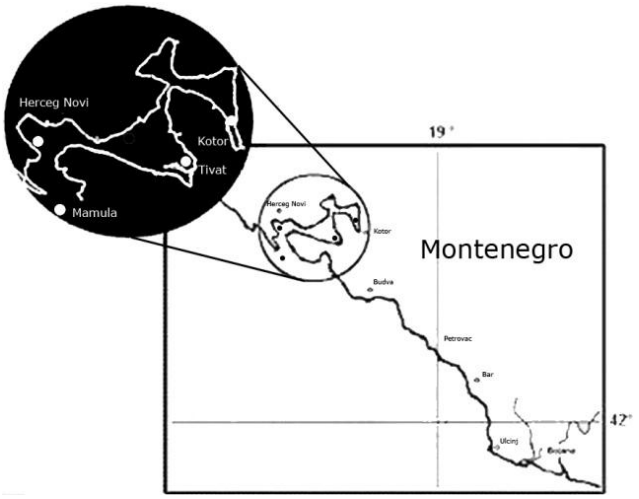


Fig. 1. Map of investigated position (Boka Kotor Bay)

Result and Discussion
The Boka Kotor Bay, as a direct recipient of pollutants of anthropogenic origin from the area, showed the higher contents of Cd, Pb, As and Hg in bottom sediments in 2005 compared to 2006 when values for those heavy metals on every examined locations was much lower [3]. Comparing values of heavy metals on each location in the Bay with referent point (location at the open sea) much higher values of every heavy metal are detected [4]. Content of Cd in the Bay was 0.541-0.869 mg/kg and on the referent point it was 0.4146 mg/kg., Pb (3.722-9.561 mg/kg), As (3.77-5.21 mg/kg) and Hg (0.029-0.098 mg/kg). At the same period of 2006 detected values are much lower and the concentrations was for Cd (0.05-0.074 mg/kg), Pb (0.028-4.79 mg/kg), As (1.75-4.45 mg/kg) and Hg (0.014-0.093 mg/kg). Average contents of heavy metals diminish in series Pb>As>Cd>Hg in 2005, while in 2006 it was in As>Pb>Cd>Hg series. The increase of lead, cadmium, arsenic and mercury on one station in Bokakotor bay can be explained as a area which is under great impact of industry and huge medical complex. Therefore there are numerous scientific studies being performed recently, directed at researching, improving and protecting the natural environment, especially water, as a limited and sensitive natural resource.

References
1 - Loring D.H., 1991. Normalization of heavy-metal data from estuarine and coastal sediments. *ICES Journal of Marine Science* 48.104.
2 - Bryan G.W., 1976. Marine Pollution. Heavy metal Contamination in the sea. In: R. Johnoston (Ed.), *Academic Press Inc*: London, 185-302.
3 - Mihajlovic R. and Joksimovic D., 2006., Pollution of the sea with heavy metals at Montenegrin Coast. Waters, Waters supply and sanitary aspects, *Conference Proceedings*, 105-112.
4 - Mihajlovic R. and Joksimovic D., 2002. Heavy metals in sediments from Boka Kotorska bay. *Studia Marina Vol*.23(1), 49-56.

HOLOCENE GEOMORPHOLOGICAL EVOLUTION OF THE KALAMAS RIVER DELTA (EPIRUS, GREECE)

V. Kapsimalis [1]*, I. Panagiotopoulos [1], P. Georgiou [1], C. Anagnostou [1], Ç. Durmishi [2], K. Pavlopoulos [3] and E. Fouache [4]
[1] Hellenic Centre for Marine Research, Institute of Oceanography - kapsim@ath.hcmr.gr
[2] Laboratory of Sedimentology, University of Tirana, Albania
[3] Harokopio University, Department of Geography, Greece
[4] University of Paris 10, Nanterre, Rouen, France

Abstract
High resolution seismic profiling acquired by a boomer and a 3.5 kHz device has revealed the configuration and internal structure of the Kalamas River prodeltaic deposits. The acoustic survey shows that during the Holocene the Kalamas River mouth moved frequently as a result of the relative sea-level rise, constructing a delta with a complicated structure. In addition, the use of aerial photographs and topographic maps demonstrates that human forcing on the fluvial system during the last 50 years has modified considerably the natural evolution of the delta resulting in the retreat of the shoreline.
Keywords: Shoreline Evolution, Seismics, Deltas

Regional setting The Kalamas River discharges into the Ionian Sea, near the Greek-Albanian borders, and creates one of the most important hydrographic networks in Greece, in terms of freshwater and sediment influxes ($1.8x10^9$ m^3/y and $1.5x10^6$ t/y, respectively), and associated wetlands (designated as a Natura 2000 site). It is 115 km long forming numerous tributaries and drains a basin of about 1830 km^2. The river plays a fundamental role in the social and economic life within the region of Epirus (NW Greece).

Results and Discussion The deltaic plain of the Kalamas River covers a surface area of about 80 km^2. Within the plain, there are some topographic irregularities with the most significant of them being the mountains Mavro (509 m) and Maskilinitsa (142 m) [1]. At an early stage of the delta evolution (from the Last Glacial Maximum to the Early Holocene), these mountains were possibly islets, whilst the river mouth was located eastwards near the village Ragio. During the Holocene, river-born deposits were settled in front the prograding Kalamas River mouth shifting the shoreline to the west and constructing, finally, the present-day deltaic plain. Since 1958, an extended reclamation project of the deltaic plain has been realized. The alignment and diversion to the north of the river lower course, the construction of a dam near Ragio and a well developed irrigation network on the deltaic plain have provided about 3200 ha for cultivation. Presently, cut off meanders and abandoned channels are still visible by the detection of aerial photographs and represent the imprints of old pathways of the river route before the human interference.
Data from seismic profiling, in the vicinity of the active northwestern river mouth, show that the subaqueous delta of the Kalamas River is extended seawards some 5-6 km, at water depths up to 30-40 m. Within the first 2-3 km away from the shoreline, the water depths are very low and do not exceed 5 m. Farther and until water depths reach 30-40 m, the seafloor slope increases abruptly and attains a value of ~4%. The prodeltaic clinoforms present an oblique tangential progradational configuration pattern, consisting probably of mud and sandy mud. In depths greater than 30 m the distal ends of these clinoforms become thinner exhibiting an apparent onlap (Fig. 1).The above lithoseismic features are similar with those appeared in the nearby Arachthos River deltaic system [2].

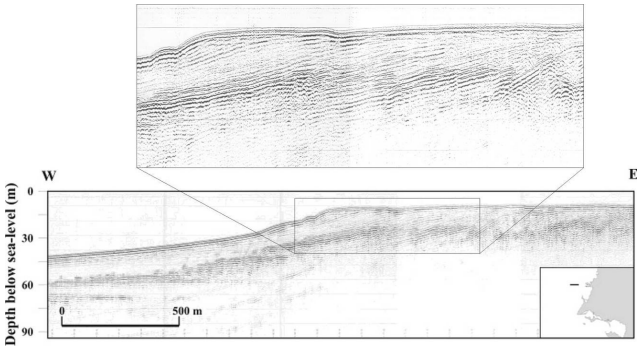


Fig. 1. High resolution seismic profile exhibiting the clinoforms pattern in front of the active Kalamas River mouth.

Seismic profiling of the area near the inactive southern river mouth (Fig. 2) indicates a high bottom gradient (>10%) and a subaqueous delta not sufficiently developed. This evidence may imply inadequate riverine sediment influx or a strong coastal hydrodynamic regime, which causes dispersion of the fluvial material into the open sea.

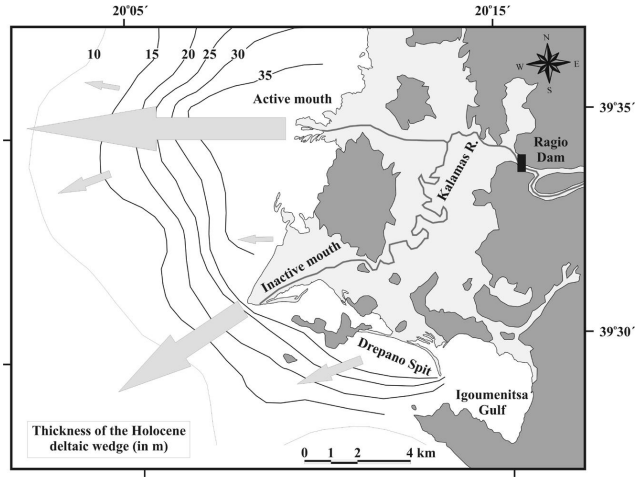


Fig. 2. Prograding directions of the Kalamas River delta. Contours (in m) indicate the thickness of the prodeltaic deposits.

In contrast, in front of the sand spit at the Drepano site (in the south part of the deltaic plain), the seismic survey displays the existence of a well built prodeltaic prism. The occurrence of this submarine lobate formation seems not to be connected with the old estuary (south) of the Kalamas River and, probably, is related to a third mouth at the Gulf of Igoumenitsa. This river mouth maybe functioned at the past as a secondary outlet without, however, ignoring the possibility to have acted as well as a primary estuary for some period of time.

References
1 - Maroukian, H., Gaki-Papanastasssiou K., Pavlopoulos K. and Zamani A., 1995. Comparative geomorphological observations in the Kalamas delta in western Greece and the Sperkhios delta in eastern Greece. *Rapp. Comm. Int. Mer. Medit.*, 34: 110.
2 - Kapsimalis V., Pavlakis P., Poulos S.E., Alexandri S., Tziavos C., Sioulas A., Filippas D. and Lykousis V., 2005. Internal structure and evolution of the Late Quaternary sequence in a shallow embayment: The Amvrakikos Gulf, NW Greece. *Marine Geology*, 222-223: 399-418.

RECENT EVOLUTION OF THE ARACHTHOS RIVER ESTUARY (NW GREECE)

V. Kapsimalis [1]*, I. Panagiotopoulos [1], S. E. Poulos [2], T. D. Kanellopoulos [1] And M. Skoularikou [3]
[1] Hellenic Centre For Marine Research, Institute Of Oceanography - Kapsim@Ath.Hcmr.Gr
[2] University Of Athens, Faculty Of Geology And Geoenvironment
[3] Aristotle University Of Thessaloniki, School Of Geology

Abstract

Data derived from historical charts, seismic profiling and sediment core analysis have indicated three migration phases for the Arachthos River mouth since 17th century and up to 1930s. Thereafter, three evolutionary stages in the geomorphology of the modern estuary occurred: rapid development of an extended deltaic lobe in front of the river mouth until 1960; deceleration of the subaerial progradation of the deltaic lobe during 1960-1987; and domination of significant erosion of the deltaic deposits from 1987 to 2000, causing shoreline retreat.

Keywords: Shoreline Evolution, Deltas, Seismics

Study area The Arachthos River discharges into the Amvrakikos Gulf (NW Greece) which is the biggest semi-closed coastal biotope (protected by the RAMSAR convention) in the Greek territory. The river is 110 km long and the cathcment basin covers an area of about 1900 km^2. The average annual freshwater and suspended sediment inputs into the Amvrakikos Gulf are about $2.2x10^9$ m^3 and $7x10^6$ tonnes, respectively [1].

Results and Discussion Reliable historical charts, published in the 17th Century, indicate that the mouth of the Arachthos River was located about 6 km to the west from its present position, at the Paleobouka site. At the end of the 19th or the beginning of the 20th Century, the mouth moved naturally to the east, approximately 1 km from its present position. During the end of the 1930's, the lowest course of the river was aligned by the construction of artificial levees and diverted more to the east, at its present position (Fig. 1).

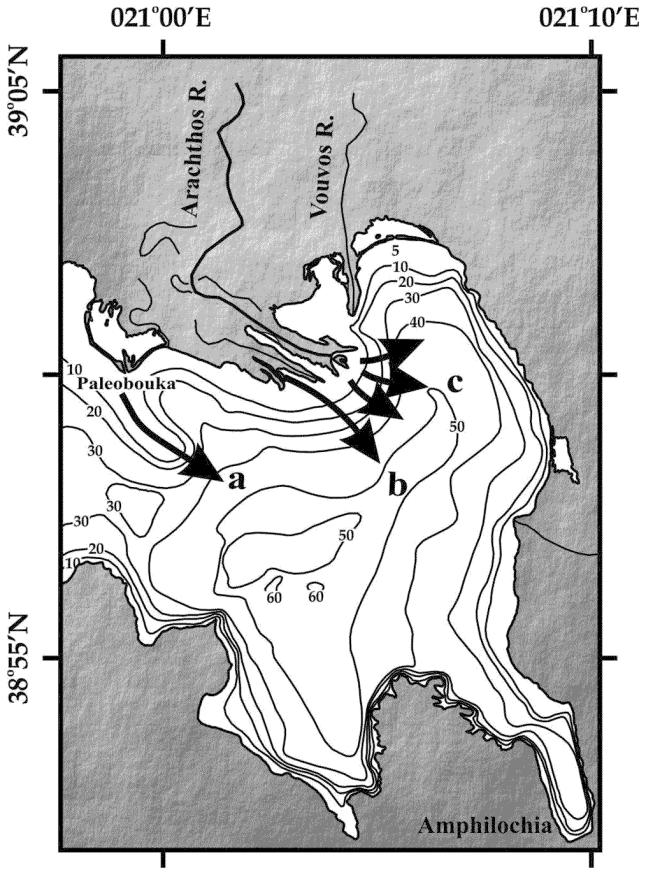


Fig. 1. Migration positions (a, b, c) of the Arachthos River mouth.

The above migration phases have been detected from high resolution seismic profiling as three equitant acoustic units within the recent prodeltaic deposits [2]. The lowest Unit C consists of almost *transparent*internal reflectors indicating distal prodeltaic deposits; it is very likely for these sediments to have come from the Paleobouka site when the river mouth was initially located there. The intermediate Unit B shows a prograding sigmoid configuration pattern, presumably, made when the river mouth was located about 1 km westwards to its present position. The uppermost Unit A is characterized by wavy reflectors representing modern foreset deposits (Fig. 2).

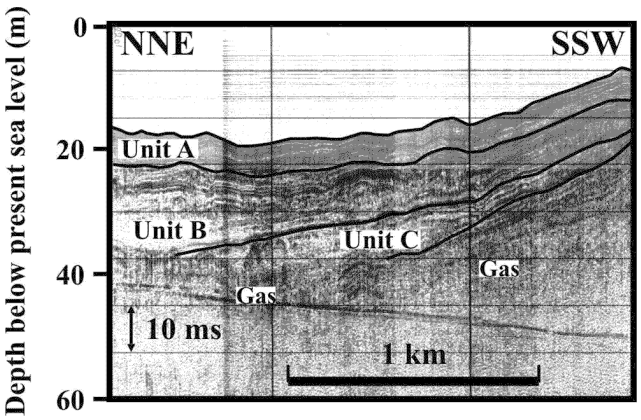


Fig. 2. High resolution seismic profile located near the present Arachthos River mouth, showing the succession of the prodeltaic deposits.

The geomorphological evolution and shoreline displacement of the Arachthos River delta during the last 70 years was identified through a Geographical Information System (GIS) manipulation and analysis of: (a) three sets of aerial photographs taken in 1945, 1960 and 1985; (b) a satellite photograph taken in 2000; and (c) topographic diagrams of a scale 1:5000 published in 1981. The interpretation and comparison of the above data demonstrate the following: After the alignment and diversion of the Arachthos River in the end of 1930's and until 1960, an extended deltaic lobe in front of the new mouth had been rapidly developed, whilst the deposits near the older mouth were being subjected to erosion. The subaerial progradation of the new deltaic lobe decelerated during the period 1960-1987, with the older river mouth suffering a further retreat. Finally, since the construction of the hydroelectric dams at the Pournari site (located 20 km upstream the river mouth) in 1981 and 1996 and the development of an extended irrigation network, the sediment fluxes into the sea have become limited and the erosion processes have already dominated the estuarine area. This will inevitably lead to a significant reduction of the currently existing wetlands with a subsequent biodiversity loss, aquifer salinization, and rapid coastal subsidence.

References

1 - Kapsimalis V., Pavlakis P., Poulos S.E., Alexandri S., Tziavos C., Sioulas A., Filippas D. and Lykousis V., 2005. Internal structure and evolution of the Late Quaternary sequence in a shallow embayment: The Amvrakikos Gulf, NW Greece. *Mar. Geol.*, 222-223: 399-418.

2 - Poulos S.E., Kapsimalis V., Tziavos C. and Paramana T., 2008. Origin and distribution of surface sediments and human impacts on recent sedimentary processes. The case of the Amvrakikos Gulf (NE Ionian Sea). *Cont. Shelf Res*., 28: 2736-2745.

SPATIAL DISTRIBUTION OF THE EVROS RIVER PLUME (NE AEGEAN SEA), USING SEASONAL SATELLITE DATA AND IN-SITU MEASUREMENTS

Aikaterini Karditsa [1]*, Serafim Poulos [1] and Nikolaos Aspiotis [1]
[1] Dept of Geography and Climatology, Faculty of Geology and Geoenvironment, Univ. of Athens, 15784, Greece - kkarditsa@geol.uoa.gr

Abstract
A three year (2006 -2008) Modis satellite data time series has been used to document the seasonal variability of the Evros river plume in the NE Aegean Sea. Satellite data were coupled with field measurements, providing the river plume distributional pattern, which leads subsequently to the quantitative estimation of plume concentrations. Winter plume is dispersed seawards towards south-west, in contrast to the summer plume, which is constrained primarily along the nearshore zone.
Keywords: Aegean Sea, River Input, Coastal Waters

Introduction - The transboundary Evros river drains a catchment of 52.000 Km2, being the largest river debouching in the North Aegean Sea. It discharges annually about 3,26 10^9 m^3 of freshwater and some 1,7 10^5 tones of sediment, mostly in suspension (Pehlivanoglou, 1989). During the last decade many studies have been referred to the Evros river plume using satellite data (Georgopoulos, 2002, Kanellopoulos, 2009) and discussed its influence on the sedimentation of the inner continental shelf of the NE Aegean Sea (e.g. Pehlivanoglou, 2000, Kanellopoulos, 2008). In general, Evros river plume follows the Samothraki anticyclonic circulation, either responding to the Coriolis Effect and/or to the local wind forcing, depending on its strength. The aim of this study is to identify the seasonal distribution pattern and the strength of the Evros River plume via the examination of inter-annual data set of MODIS images.

Data collection and methodology - All the available MODIS (Level 1A) swaths intersecting the region 40º28'-40º54'N and 25º31'-26º 12'E for the period of January 2006-December 2008 were downloaded from the Goddard Distributed Active Archive Center. These data were processed to Level 2 TSM product using default NASA coefficients and TSM_Clark standard algorithm, as implemented by SeaDAS. Monthly averages were calculated from available products and composited further into seasonal means, considering October–March and April–September, as winter and summer periods, respectively. Data were re-mapped to WGS'84 (Zone 35ºN) Mercator projection. The algorithm product was calibrated comparing filtered surface water samples, obtained from 12 stations, on the 8th and 11th of September of 2008 to the corresponding pixel value of the Level 2 TSM products for the same dates. Field data were filtered through pre-weighed 0.7μm (FG/G –Wattman, 47mm diameter)) glass-fibber filter and after dried, reweighed again for the determination of the Total Suspended Matter (TSM) concentration. A least-squares application provided the equation (1), which describes nearly the 89% of the variability. TSM= 0.1065 *pv+0.2423 (1) where, pv= L2 TSM product pixel value. Finally, in order to trace plume characteristics, a Natural Breaks classification method, with the use of a GIS tool, was applied to the output seasonal product, classifying four different TSM concentration classes.

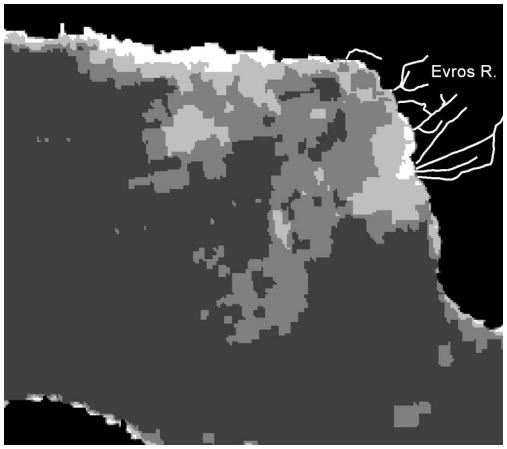


Fig. 1. Winter Evros River plume classification

Results

The spatial distribution of the winter plume had mainly a south-west orientation. On the basis of the spatial distribution of four water spectral classes the following water types were identified (Figure 1): (1) the immediate plume core; (2) the plume edges and nearshore waters; (3) the peripheral plume and the inner shelf water; and, (4) the offshore water. The first class refers to the main plume core, with values greater than 0.25mg/lt, functioning during the whole winter period. The second category (0.10-0.25mg/lt) depicts the intermediate region of the plume and the nearshore waters being turbid due to resuspension induced by the wave activity. The third type is the peripheral region of the plume (0.05-0.10 mg/lt) whilst the forth class regards to the common TSM offshore water values (<0.05 mg/lt).

The summer plume, being associated with low riverine water/sediment fluxes was mainly constrained close to the coast, coinciding with the nearshore zone.



Fig. 2. Summer Evros River plume classification

Conclusions - The systematic analysis of the satellite imagery data coupled by seasonal in-situ data show that the interannual plume pattern during winter extends seawards to the south-west; this is attributed to the high river discharge and the influence of the offshore anticyclonic circulation. During summer period, the weak riverine influxes restrict plume distribution within the nearshore zone at either side of the mouth area controlled by the coriolis effect and the directions of prevailing winds (mostly N/NE during summer).

References
1 - Georgopoulos D., 2002. Water masses, dynamics and circulation in the Northern Aegean Sea. PhD Dissertation. University of Patra, Greece (in Greek).

2 - Kanellopoulos TD, Kapsimalis V, Poulos SE, Angelidis MO, Karageorgis AP, Pavlopoulos K., 2008. The influence of the Evros River on the recent sedimentation of the inner shelf of the NE Aegean Sea. *Environ Geol* 53:1455–1464.

3 - Kanellopoulos TD, Angelidis MO., Georgopoulos D., Karageorgis A., 2009. Fate of the Evros River suspended particulate matter in the northern Aegean Sea. *Environ Geol* 57:1729–1738.

4 - Pehlivanoglou K., 1989. Evros delta: evolution of continental shelf sediments. *Mar Geol* 87:27–29.

5 - Pehlivanoglou, K., Tsirambides, A., Trontsios, G., 2000. Origin and distribution of clay minerals in the Alexandroupolis Gulf, Aegean Sea, Greece. Estuarine, *Coastal and Shelf Science* 51, 61–73.

A COMPARISON OF BIOTIC INDICES IN ASSESSING ECOLOGICAL QUALITY AT THE NE AEGEAN SEA (MYTILENE STRAIT, LESVOS ISLAND)

N. Katsiaras [1]*, A. Evagelopoulos [1], A. Atsalaki [1], D. Koutsoubas [1] and N. Simboura [2]
[1] Hellenic Centre for Marine Research, Institute of Oceanography
[2] Department of Marine Sciences, University of the Aegean - mar01042@mar.aegean.gr

Abstract
The performance of three biotic indices (AMBI, Bentix, M-AMBI) has been compared in communities of soft sediment habitats (mostly covered by *Posidonia oceanica* meadows) at a coastal area of the NE Aegean Sea. AMBI and Bentix had similar trends, but M-AMBI's dependence to Shannon diversity rendered a more degraded state, possibly due to the dominance of species related to HP communities.
Keywords: Zoobenthos, Coastal Systems, Bio-Indicators, Aegean Sea

Introduction
The implementation of the Water Framework Directive (2000/60/EC) requires the development of new biotic indices that would be capable of (a) responding to anthropogenic disturbance, (b) distinguishing different levels of ecological quality and (c) being applicable in any geographical area. The past years, a number of such biotic indices have been developed and tested. Although robustness seems to be a common merit in these indices, this study aims to evaluate their suitability in the ecological attributes at a particular regional scale. In order to accomplish sufficient index performance comparisons, the influence of local and regional natural variability and the nature of the habitat and ecosystem element on index accuracy and stability must be investigated [1].

Study Area and Methods
The coastal area of Mytilene Strait (NE Aegean Sea) is considered to have low urban development; however tourism and population seem to have increased over the last decade. In a baseline study during 2007, the local human pressures and the suitability of indices (classifying the ecological status) were investigated. The first sampling station was located in an area where no significant human activity was identified and the rest four stations were selected according to possible sources of environmental degradation (waste treatment plant-Station 2, port-Station 3, aquaculture units- Station 4 and 5). Quantitative samples were collected, by a Van Veen grab, from soft sediments mostly covered by *Posidonia oceanica* meadows. Species Richness (S) and the Index of Shannon Diversity (H') were calculated. Bray-Curtis similarity analysis was also applied. The biotic indices Bentix [2], AMBI [3] and M-AMBI [4] were used to classify the ecological status. For the application of M-AMBI, the reference conditions of mixed sediments (H'=6, S=120, AMBI=0) were used, as suggested by Simboura and Reizopoulou [5].

Results
A total of 6574 individuals belonging to 247 taxa were identified. The gastropods *Bittium reticulatum*, *Jujubinus striatus*, *Alvania geryonia* and *Pusillina marginata* were the most abundant in the first three sampling stations. It is noteworthy that the individuals of *Bittium reticulatum* represented 35.85% of the total abundance. Species Richness (S) had the highest value in Station 4 (102 species), comparatively high in the previous three stations and the lowest value in Station 5 (42 species). The highest values of Shannon diversity (H') were recorded in Station 4 and 5 (4.71 and 4.48), whereas the values of Stations 1 to 3 were 3.65, 3.58 and 3.91 respectively. Through Bray-Curtis similarity analysis, three main clusters were identified; the group formed by Stations 1 to 3, Station 4 and Station 5.The application of Bentix and AMBI classified all stations to High status, except of Station 5 which was classified to Good status. M-AMBI designated only Station 4 to High status and rendered a more degraded state at the first three Stations (Good status) and at Station 5 (Moderate status). According to Bentix classification, the group of sensitive species has a percentage over 93% at all Stations apart from Station 5. Among the ecological groups of AMBI/M-AMBI classification, only Group I and II seemed to be significant at the same Stations, while Group I had a much higher percentage than Group II (between 71% and 86.1%).

Discussion
All three biotic indices seemed to be sufficiently sensitive to the level of anthropogenic disturbance caused by the aquaculture units at Station 5. The Good status is similar to what it has been found in previous research effort regarding the effects of local aquacultures to the benthic communities [6]. A large convergence of the assessment is noted for station 4 among all indices and for Stations 1 to 3 among AMBI and BENTIX, while M-AMBI seems to underestimate condition in relation to the other indices. Because of the high percentage of Group I and the ecological status shown by AMBI, the M-AMBI difference could be attributed to the apparent influence of this index by Shannon Diversity and its dependence to methodological and ecological factors rather than to anthropogenic disturbance. It is known that the dominance of certain species produces low diversity estimations, although those species are usually related to non-polluted environments [7]. In certain stations, the dominance of *Bittium reticulatum* seems to be associated to the presence of *P. oceanica* meadows [8] and therefore it could not be related to anthropogenic pressures, but to the ecological attributes of the local habitats. The non-multivariate classification to ecological groups (as applied by Bentix and AMBI) , seems to capture the ecological status sufficiently and it is also validated by the analysis of other abiotic/biotic measurements in the study area [9]. However, this conclusion could not be directly linked to the health status of *P. oceanica* meadows in the study area and it is pointed out that the successful estimation of ecological status based on macrophytes and their associated assemblages remains a priority issue.

Tab. 1. The values of Species Richness (S) , Shannon Diversity (H'), EQR and the classes of ecological quality for AMBI, Bentix and M-AMBI in the 5 sampling stations

Stations	S	H'	AMBI (EQR)	Bentix (EQR)	M-AMBI (EQR)
1	89	3,65	High (0,96)	High (0,97)	Good (0,76)
2	72	3,58	High (0,96)	High (0,97)	Good (0,72)
3	95	3,91	High (0,96)	High (0,97)	Good (0,79)
4	102	4,71	High (0,94)	High (0,95)	High (0,83)
5	42	4,48	Good (0,78)	Good (0,68)	Moderate (0,60)

References
1 - Borja A., Miles A., Occhipinti-Ambrogi A., Torsten B., 2009. Current status of macroinvertabrate methods used for assessing the quality of European marine waters: implementing the Water Framework Directive. Hydrobiologia 633: 181-196
2 - Simboura, N., Zenetos, A., 2002. Benthic indicators to use in ecological quality classification of Mediterranean soft bottom marine ecosystems, including a new biotic index. Mediterranean Marine Science 3/2: 77–111.
3 - Borja, A., Franco, J., Perez, V., 2000. A marine biotic index to establish the ecological quality of soft-bottom benthos within European estuarine and coastal environments. Marine Pollution Bulletin 40 (12): 1100–1114
4 - Muxica, I., Borja, A., Bald, J., 2006. Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European Water Framework Directive. Marine Pollution Bulletin (55): 16–29.
5 - Simboura N., Reizopoulou S., 2008. An Intercalibration of classification metrics of benthic macroinvertebrates in coastal and transitional ecosystems of the Eastern Mediterranean ecoregion (Greece). Marine Pollution Bulletin (56): 116-126
6 - Dimitriadis, Ch. & Koutsoubas, D. 2008. Community properties of benthic molluscs as indicators of environmental stress induced by organic enrichment. Journal of Natural History (42): 559-575
7 - Salas, F., Neto, J.M., Borja, A., Marques J.C., 2004. Evaluation of the applicability of a marine biotic index to characterize the status of marine estuarine ecosystems: The case of Montenegro estuary (Portugal). Ecological Indicators 4: 215-225
8 - Peres J. M., 1967. The Mediterranean Benthos, Oceanography Biology Annual Review (5): 449-533
9 - Karantanelli M., Vagi M., Petsas A., 2008. Interim report: Quality of coastal ecosystems. Interreg IIIC "Hellas-Cyprus" (In Greek)

DISTRIBUTION AND FATE OF THE ORGANIC MATERIAL DISCHARGED BY THE RHONE RIVER

P. Kerhervé [1]*, R. Buscail [1], N. Bossard [1], G. Jeanty [1], J. Carbonne [1] and C. Rabouille [2]
[1] CEFREM UMR CNRS 5110 - Université de Perpignan, 66860, France - kerherve@univ-perp.fr
[2] LSCE-IPSL, 91191, Gif sur Yvette Cedex, France

Abstract
Within the framework of the ANR-CHACCRA program, a monthly sampling of suspended particles (SP) on the downstream part of the Rhone River (Arles station) has been performed during 4 years (2006-2009), combined with seasonal cruises on the Rhone prodelta for collecting sediments. Carbon and nitrogen content, stable isotope ratios ($d^{13}C$ and $d^{15}N$) and biochemical analyses have been performed on these materials in order to understand the role of Rhone River in the distribution of the particle organic material and its fate within a coastal environment (prodelta area).
Keywords: Gulf Of Lions, Rhone Delta, River Input, Sediments, Organic Matter

Continental shelves are dynamic sedimentary environments that receive, store and export high amounts of organic carbon (OC) and nitrogen (N) introduced by a variety of terrestrial and marine sources. Rivers provide the major pathways for the input of terrestrial organic matter to marine sediments. The Gulf of Lions is a key area of the Mediterranean Sea since it receives the Rhone River discharge, the largest river input into the Mediterranean Sea in terms of liquid and solid fluxes [1].

The purpose of our study is to compare the variations in term of flux and quality of the riverine particulate organic material (RPOM) from the Rhone River with the distribution and the quality of the sedimentary organic material (SOM) from the Rhone prodelta. The strategy developed within the framework of the ANR-CHACCRA program is based on a monthly sampling of Rhone RPOM at Arles started in January 2006 and on coastal cruises (April 2007, September 2007 and May 2008) for collecting sediments off the Rhone mouth. Carbon and nitrogen contents (OC%, N%) and stable isotope ratios ($d^{13}C$ and $d^{15}N$) were performed to assess the Rhone inputs and to follow this material once settled off the mouth. Further analyses on the three main organic classes (protids, lipids, sugars) were achieved also on sediments and some river samples to characterize the OM, investigate its spatial and temporal distributions. Our results exhibited a relation between the quality of the SOM with seasons and regimes of the Rhone River. Moreover, taking into account the large size of the Rhone watershed, our survey showed that floods can discharge two kind of RPOM that should follow different fate in coastal sediments. We knew that the RPOM fluxes change markedly according to seasons and floods and now, we have to integrate the temporal heterogeneity in the nature of RPOM in further studies. What are the responses of the prodelta benthic fauna to this heterogeneity? As extreme hydro-climatic conditions on the shelf of the Gulf of Lions may induce large transfer (e.g. cascading event) of this RPOM to the deep basin [2], does this RPOM heterogeneity in term of nature influence the deep ecosystems?

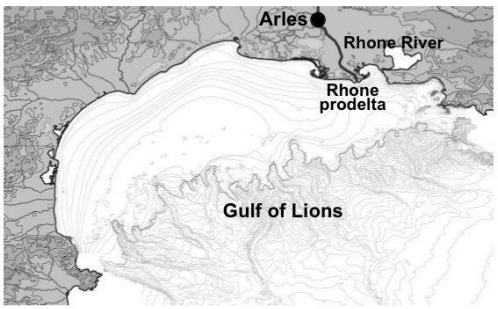


Fig. 1. Location of the study area

References
1 - Sempéré R. Charrière B., Van Wambeke F., Cauwet G., 2000. Carbon inputs of the Rhône River to the Mediterranean Sea: biogeochemical implications. *Global Biogeochemical Cycles*, 14(2), 669-681.

2 - Sanchez-Vidal A., Pasqual C., Kerhervé P., Heussner S., Calafat A., Palanques A., Durrieu de Madron X., Canals M., and Puig P., 2009. Across margin export of organic matter traced by stable isotopes during and off cascading events, Northwestern Mediterranean Sea? *Limnology & Oceanography*. 54(5) 1488-1500.

CONTAMINATION PAR LES MÉTAUX LOURDS DE LA FRANGE CÔTIERE DE TETOUAN: KABILA À L'EMBOUCHURE D'OUED LAOU

Soumaya Khannous [1]*, Hassan Er-Raioui [1] and S Bouzid [1]
[1] Faculté de Sciences et Techniques de Tanger, 90000, Maroc - khsoumaya@yahoo.fr

Abstract
La contamination de l'écosystème littoral par les métaux lourds constitue l'un des problèmes majeurs en toxicologie environnementale. À la différence des polluants organiques, les métaux lourds ne font pratiquement pas l'objet de biodégradation. Ils peuvent alors s'accumuler dans les chaînes alimentaires pour atteindre des seuils toxiques [1]. Cette étude, réalisée en 2006 – 2007 sur des organismes bivalves (*Castilla Chione*) et ayant pour objectif de caractériser l'état de la contamination de la frange côtière de Tétouan (Kabila - Embouchure d'Oued Laou) par les métaux lourds a révélé la contamination de ce littoral par certains métaux.
Keywords: Mollusca, Metals, Mediolittoral

Introduction
Parallèlement au développement industriel et de l'urbanisme, la contamination générale des côtes par des produits organiques et chimiques est devenue une véritable préoccupation. Ces polluants considérés comme dangereux provoquent des effets néfastes sur l'écosystème marin, en l'occurrence les ressources halieutiques. Des études antérieures [2] portant sur le suivi chimique des coquillages décrivent des teneurs caractéristiques des zones salubres. Bien qu'inférieures aux normes admises, les concentrations en Pb enregistrées sont plus élevées que celles du Cd et du Hg au niveau de l'ensemble des sites étudiés. Les résultats montrent également que les variations annuelles sont irrégulières, rendant difficile l'interprétation des tendances.

Matériels et Méthodes. Des échantillons de vernis ont été récoltés au niveau de six stations. Les prélèvements ont été étalés sur un cycle annuel de juillet 2006 à juin 2007 avec une périodicité saisonnière. Les échantillons d'organismes bivalves (*Castilla Chione*), considérés comme des accumulateurs potentiels de polluants et largement utilisés dans la bio-surveillance des eaux de mer, ont été décortiqués, broyés et lyophilisés. La minéralisation a été effectuée par l'acide nitrique et à l'acide sulfurique. Après minéralisation, les métaux lourds (Cd, Cu, Zn, Cr, Pb et Ni) ont été analysés par spectrométrie d'émission optique (ICP).

Résultats et discussions
Les teneurs en métaux enregistrées dans les différents sites analysés sont exprimées en mg/kg du poids sec varient de 54 à 66,50 pour le zinc, de 7,45 à 13,13 pour le nickel, de 0,25 à 4,8 pour le plomb, de 4,70 à 6,9 pour le cuivre, de 1,25 à 3,67 pour le chrome et de 0,1 à 0,35 pour le cadmium. Les concentrations ne sont pas négligeables bien que les activités industrielles et portuaires soient moins développées que dans les pays industrialisés. Les concentrations en métaux chez les organismes étudiés montrent des fluctuations importantes et laissent penser à une bioaccumulation sélective par rapport à certains métaux (Figure. 1). Ceci peut refléter le processus de compétition pour les sites d'adsorption.

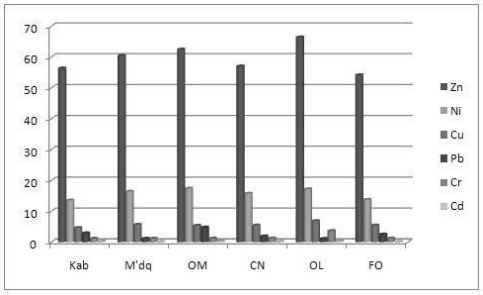


Fig. 1. Concentrations moyennes annuelle des métaux lourds (Cd, Cr, Cu, Ni, Pb, Zn) en mg/kg de poids sec dans les différents sites étudiés (kab : Kabila, M'dq : M'diq, OM : Oued Mellah, CN : Cabo Negro, OL : Oued Laou, Emb : Embouchure d'oued

Les concentrations en Zn montrent les valeurs les plus élevées, suivies de celles relatives au Ni et au Cu, et enfin celles correspondant au Pb. Cette même distribution a été également enregistrée par certains auteurs pour différentes espèces de gastéropodes de l'étang de Berre (France) [3]. L'ordre d'importance des teneurs métalliques dans l'étang de Berre est le suivant : Zn > Cu > Pb > Hg. L'analyse des concentrations des moyennes annuelles des métaux étudiés chez *Castilla chione* ne marque qu'une légère variation spatiale.

Dans la figure 2, représentant les variations saisonnières des concentrations moyennes des métaux enregistrées chez *Castilla Chione*, il apparaît que les concentrations relatives aux différents métaux Zn, Ni, Cu, Pb, Cr et Cd varient de la même façon dans le temps. Ces métaux montrent une légère variation temporelle.

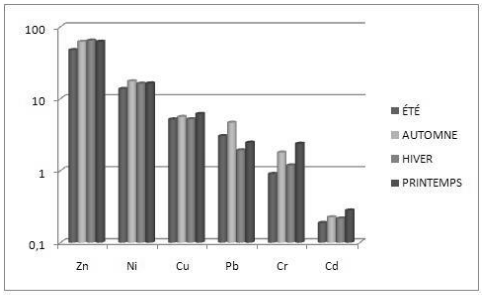


Fig. 2. Les variations saisonnières des concentrations moyennes des métaux (Zn, Ni, Cu, Pb, Cr, Cd) enregistrées chez *Castilla Chione*.

Par ailleurs, il convent de souligner que les concentrations enregistrées le long de la frange étudiée restent faibles comparées aux concentrations relevées chez des espèces voisines prélevées dans des sites pollués ou non faisant partie de la Méditerranée française, des côtes algériennes ou du littoral atlantique marocain au niveau de Rabat, Salé et Mohammédia [4], [5].

References
1 - Cumont G., 1984. La contamination des aliments par le mercure. Ann. Fals. Exp. Chem. 77.
2 - Rapport interne, 2000. Résultats de surveillance de la salubrité du littoral marocain. INRH.
3 - Catsiki A.V., Arnoux A., 1987. Etude de la variation des teneurs en Hg, Cu, Zn et Pb de trois espèces de mollusque de l'étang de Berre (France). Mar. Environ. Res., 21.
4 - Boutier B., 1982. Synthèse des résultats de la surveillance des micropolluants dans la matière vivante. Bull. R. N. O. N° 17.
5 - Chafai El Alaoui S., 1994. Etude de quelques aspects de la contamination métallique chez certains mollusques et poissons marins (côtes atlantiques marocaines) : étude environnementale et approche expérimentale. Thèse de 3ème cycle, Univ. Caddi Ayyad, Marrakech (Maroc).

LITTER COMPOSITION AND SOURCE IDENTIFICATION FOR 80 BEACHES IN GREECE

S. Kordella [1], G. Papatheodorou [1]*, M. Geraga [1], E. Fakiris [1] and A. Mitropoulou [2]
[1] LABORATORY OF MARINE GEOLOGY AND PHYSICAL OCEANOGRAPHY, DEPARTMENT OF GEOLOGY, UNIVERSITY OF PATRAS - gpapathe@upatras.gr
[2] Mediterranean S.O.S Network

Abstract
Composition of beach litter was assessed for 80 beaches in Greece, with the participation of the volunteers of the international campaign "Clean up the Med 2006 & 2007", coordinated in Greece by the N.G.O Mediterranean S.O.S. This study showed that plastic is the dominant litter material, followed by paper and aluminium. Furthermore, public participation in beach litter surveys is proposed as an appropriate method to promote environmental awareness.
Keywords: Pollution, Beach, Coastal Management, Eastern Mediterranean

Introduction
Although numerous studies have been carried out on marine debris globally, in Greece marine litter research is very limited [1]. The aim of this study is to (i) evaluate beach litter composition, for the first time in Greece for a significant amount of coasts (80), with the participation of volunteers [2] and (ii) explore the relations between the different litter materials and marine and land – based beach litter sources.

Methods
For the purposes of the present study, data were collected with the collaboration of volunteers who participated in the "Clean Up The Med 2006 & 2007" Mediterranean campaign of voluntary beach clean - ups, that is coordinated by the Italian N.G.O. Legambiente and for Greece by the environmental N.G.O. Mediterranean S.O.S. In Greece, thousands of volunteers (2006: 10,938, 2007: 15,748) participate each year in the Clean up the Med campaign that not only aims at physical removal of beach debris, but also at raising public awareness and education on marine pollution issues, through dissemination of informational material as well as a questionnaire, the "Beach Observation Questionnaire" (B.O.Q). The B.O.Qs, which were filled in from the volunteers during the clean – up, acquire qualitative information regarding the probable beach litter sources, as well as litter composition data. The volunteers counted and classified the items of litter found in the beaches according to their composition, in eight categories: glass, plastic, paper, aluminium, other metals, rope, building materials and other materials (Table 1). The "other materials" category was excluded from the data processing for reasons of results interpretation. B.O.Qs from 49 beaches were processed in 2006 and from 31 beaches in 2007 (Fig.1).

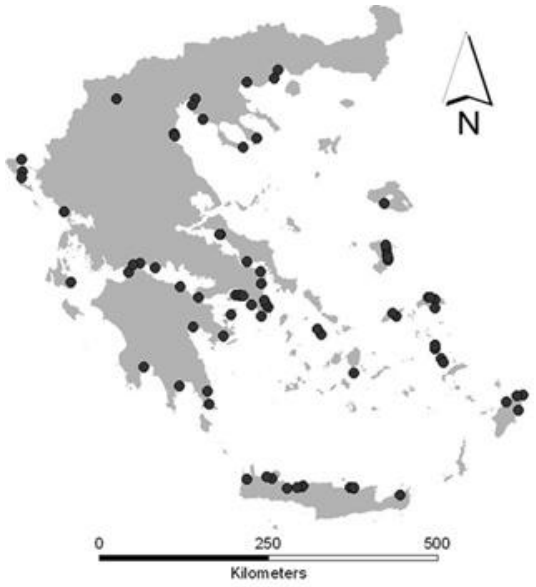


Fig. 1. Map showing the 80 beaches (dots) studied in Greece.

The qualitative information includes the litter sources that affect each beach. Litter sources were distinguished in two major groups: land – based and marine – based. Land – based litter sources, were separated in two minor groups: a) sources that are involved with recreational activities that usually take place on the beach (e.g. bathing) and b) sources that do not interfere directly with recreational activities, such as rivers, municipal drainage systems, ephemeral streams and sewage inputs, refuse dumps. Marine – based litter sources were separated in: a) sources referring to commercial and recreational fishery and b) sources concerning with navigation (merchant ships, ferries and recreational boats).

Results and Discussion
Plastic was the dominant litter material (Table 1) in the majority (69 beaches) of the beaches that were surveyed, in accordance with the global tendencies [1, 3]. Plastic dominance was followed in both periods by paper and aluminium. However, in 11 out of 80 beaches paper was the most abundant material indicating recent pollution [3]. In two beaches the dominant litter material was aluminium and in one beach building materials suggesting local influence. The qualitative information in combination with the litter composition data, showed that the majority of beaches (56) were polluted by recreational activities while the most dominant marine based litter source was navigation (46 beaches). Moreover, land based sources that do not relate with recreation; seem to pollute the beaches with building material; while fishery appears to be responsible for metallic (apart aluminium) items of litter on the Greek surveyed beaches. The present large scale study would not have been achieved without the participation of volunteers whose involvement in coastal management issues can lead to environmental awareness [2].

Tab. 1. Mean values of the litter material categories. "Other metals": litter made of any metal but aluminium; "Building materials": material used for construction; "Other materials": litter that cannot be classified in any of the other categories.

Litter Material Categories	*2006 Mean (%)*	*2007 Mean (%)*
Glass	5	6
Plastic	43	51
Paper	13	18
Aluminium	12	7
Other Metals	4	3
Rope	8	6
Building Materials	5	2
Other Materials	10	7

References
1 - Koutsodendris, A., Papatheodorou, G., Kougiourouki O., Georgiadis M., 2008. Benthic marine litter in four Gulfs in Greece, Eastern Mediterranean; Abundance, composition and source identification. *Estuar. Coast Shelf Sci.*, 77: 501-512.
2 - Bravo, M., de los Ángeles Gallardo, A., Luna-Jorquera, G., Núñez, P., Vásquez, N., Thiel, M., 2009. Anthropogenic debris on beaches in the SE Pacific (Chile): Results from a national survey supported by volunteers. *Mar. Pollut. Bull.* 58: 1718-1726.
3 - Derraik, J.G.B., 2002. The pollution of the marine environment by plastic litter: a review. *Mar. Poll. Bull.* 44: 842-852.

THE NOWADAYS STATE OF THE SEA OF AZOV RUSSIAN COAST

Ruben Kosyan [1] and Marina Krylenko [1]*
[1] Southern branch of the P.P.Shirshov Institute of oceanology, RAS - krylenko@mail.ru

Abstract
When elaborating and implementing coast protection measures it is necessary to take into consideration the existence of lithodynamical systems including sources of nourishment, transit and accumulation of sediments. The Sea of Azov coast protection systems, which take into account geological, hydro-lithological and economical peculiarities of the coast, well combine the efficiency of coastal protection with the possibility to use the shore for recreation and economic purposes.
Keywords: Coastal Management, Coastal Systems, Sea Of Azov

The Sea of Azov coast has a large economic potential. Today a rate of its opening up is considerably increased. Old industrial and transport objects on a shore are reconstructed and new ones are built. Stability of inter-political situation, comfort climatic conditions, richness of the area with natural, cultural and historical places, ease to access the area and development of the transport net make the Kuban-Near-Azov region a very attractive for a recreation field of economy. Complex study of modern coastal processes affords to single out three main types of coasts: abrasion (abrasion-landsliding), accumulative and stable ones. A length of eroding coasts within this section is 240 km, that of accumulative one – 230 km. A length of relatively stable coast is about 120 km. Spits Chushka, Achuevskaya, Yasenskaya, Kamyshevskaya, Dolgaya may be considered as accumulative forms, which are fed due to bottom sediments from bars of Khanka Lake, Beisugsky and Akhtanizovsky firths are widely spread. Today a part of accumulative coast undergoes erosion. Especially intensive is erosion of Dolgaya spit. In 2008 in some places a rate of the eastern coast retreat was 4-6 m. Abrasion coast can be observed near Primorsko-Akhtarsk and Yeisk towns, near Cape Kameny, to the north of Glafirovskaya spit and in other places. A rate of retreat of the coast cliffs is 1.8-2 m per year, and in some places it is 5-7 m/yr. Every year tens of hectares of lands are lost, during the last 100 years a belt of land, 500-600 m wide, was cut by sea [1]. Such a high rate of abrasion may be explained both by the influence of natural (geological structure of coasts, rising of the water level by the effect of wind) and anthropogenic factors. Erosion of coasts composed of loess loams practically does not give a material for a beach formation. During the period of water level rising under wind storm waves influence directly upon coast cliff coast retreat can reach several tens of centimeters during one storm. Stable coasts where abrasion and accumulative processes are not well defined today are observed in firths and between mouths of the rivers Protoka and Kuban. It should be noted that a term "Stable" can be used only in a sense of relatively weak influence of waves directly upon the shore. At the same time a coastline retreats in many places, especially between rivers the Kuban and the Protoka and this can be explained by a relative rise of a sea level and by the other processes. A human activity in the Sea of Azov basin has resulted in a great transformation of its ecosystem and this has affected on the structure of alongshore sedimentary flows. River solid run-off, abrasion products and products of biogenic origin are the main sources of material supply into the coastal zone. Construction of water storage basins results in the decrease of solid run-off in several times as compared with natural regime [2]. Decrease of natural reproduction of mollusks and uncontrolled shell withdrawals are important reasons of erosion of unique shell spits [3]. Retreat of a coastline results in destruction of arable lands and industrial objects situated on shore. To prevent this, local coast protection complexes are created within inhabited localities, as a rule. A total length of protected sections of the Sea of Azov coast within the Krasnodar region is about 30 km. When the whole length of the coast is 572 km. Coast protection has realized with the help of bank retaining walls, baffle plates, artificial beaches, rip-rap berms, fills of figure blocks, groins, breakwaters and other erections. Today a majority of existing constructions are insufficiently effective ones; many of them are damaged or destroyed. A large mobility of sediments, landsliding and sagging, oscillations of sea level under effect of wind create additional troubles for coast protection [4]. Walls of different design were built in Morozovsky and Tamarinsky settlements, on the southern coast of Yeisky firth, in Dolzanskaya Stanitsa. Some of them need a reconstruction, the other is damaged, and neighbor coast sections undergo intensive erosion. The state of the coast protected by rip-raps or artificial beaches is considerably better one. Man-made beaches are a part of the coast protection complex in Prtimorsko-Akhtarsk town near lighthouse, in Alexandrovka settlement. They are 10-20 m wide and they protect coast from erosion well enough. Building of complex coast protection constructions including artificial beaches in combination with different kinds of sediment holding erections can be recommended for protection of the southeastern coast of the Sea of Azov. It's better to make berms, groins and heels in riprap variation. Such constructions keep sediments better owing to a high roughness of side planes and cavities; they better scatter wave energy and do not break a compositional integrity of a natural landscape. Correctly designed anthropogenic elements increase diversity of landscape and promote its attractiveness. Since a near shore zone is a shallow one, the use of interrupted breakwaters which suppress wave energy behind the breakwater can give good results. And then a wave shadow is created between the shore and an erection, accumulation of sediments occurs. Building of wave suppressing erections of large stones or figure blocks is possible outside the recreation zones.

References
1 - Peshkov V.M., 2000. Sea coasts. Krasnodar: "Kubansky uchebnik", 140 p.
2 - Simonov V.G., 1989. Hydrology of river mouths of the Sea of Azov. M: Hydrometeoizdat.
3 - Kos'yan R.D., Peshkov V.M., Yesin N.V. and Shcherbakov S.Yu., 2000. Carbonate beaches of the eastern part of the Sea of Azov under anthropogenic impact. Proc. of the Int. Conf. "Carbonate Beaches".
4 - Peshkov V. M., 2003. Coastal zone of sea. Krasnodar: "Lakont", 350 p.

FISH ASSEMBLAGES OF TWO ADJACENT COASTAL LAGOONS IN RIVER NESTOS DELTA (NE GREECE)

M. Koutrakis [1]*, A. Sapounidis [1], D. Lachouvaris [1], D. Chariskos [1] and A. Mirli [1]
[1] NAGREF - Fisheries Research Institute - manosk@inale.gr

Abstract
The fish fauna diversity of two adjacent coastal lagoons in northern Greece, after 12 months sampling (Vassova 25 species and Erateino 27 species), is used as an indicator of the water quality in these lagoons.
Keywords: Lagoons, Aegean Sea, Fishes

Introduction
The fish fauna can be used as an indicator of the environmental quality of the lagoons.Vassova and Erateino lagoons are situated in the northern Aegean Sea, at the western bank of Nestos River delta (Northern Greece). Vassova lagoon is approximately 270 ha in surface area with a mean depth of 0.8 m. Erateino lagoon is larger in surface area (350 ha) with a mean depth of 1.1 m.

Materials & Methods
Fish were collected monthly from August 2007 to July 2008, using a nylon centre-bag seine net (2 mm bar mesh size) of 12 m length and 1.2 m height. The bag seine was hauled for 30–50 m to cover an area of 250 m^2, approximately. The relative abundance was estimated by the Catch per Unit Effort method (CPUE: specimens/100 m^2) [1]. Sampling was conducted in two stations; one close to the entrance one inside the lagoons.

Results & Discussion
Overall, 36 species representing 19 families were identified in both lagoons (Table 1). 25 of them were identified in Vassova (24 in the entrance and 11 in the inside) and 27 in Erateino lagoon (22 of which were found in the entrance and 20 in the inside). From the above species the residents are almost the same in all stations (7 to 9). The migrant species are 10 and 11 in Erateino entrance and inside respectively but 13 in the Vassova entrance and only 4 in the inside. The low number of migrant species found inside the Vassova lagoon can be linked to the low water quality in the lagoon, which is also indicated by the low DO concentration [2]. Probably this is the reason that the species prefer to remain in the entrance of the lagoon where due to the tidal water movement the environmental conditions are better. The fact that almost the same number of species was found in the entrance and in the inside of the Erateino lagoon, indicates a possibly higher water quality in contrast to the Vassova lagoon. The dominant species in the lagoon is the *Pomatoschistus* sp., with an abundance of 537 to 1495 individuals/100 m^2. It is followed by *Atherina boyeri*, showing higher abundance in the inside of the Erateino lagoon (246 ind./100 m^2 *Aphanius fasciatus* again in the same station (230 ind./100 m^2), and by all species of the Mugilidae family.

Tab. 1. The fish species and their abundance (individuals/100 m^2) found in both Vassova and Erateino lagoons (Nestos river delta, NE Greece)

	Family	Species	Life cycle	Vassova - Entr	Vassova - Ins	Erateino-Entr	Erateino-Ins
1	ATHERINIDAE	*Atherina boyeri*	Resident	98,3	120,0	99,8	246,5
2	BLENNIIDAE	*Parablennius sanguinolentus*	Migrant	1,1		1,0	
3		*Salaria pavo*	Resident		0,4		1,0
4	CALLIONYMIDAE	*Callionymus risso*	Migrant	0,3			
5	CLUPEIDAE	*Sardinella aurita*	Straggler			9,5	10,3
6	CYPRINODONTIDAE	*Aphanius fasciatus*	Resident	0,5	55,0	1,3	230,8
7	ENGRAULIDAE	*Engraulis encrasicholus*	Straggler			0,8	
8	GOBIIDAE	*Gobius geniporus*	Resident	0,8		1,5	
9		*Gobius niger*	Resident	0,9	6,3	3,5	14,5
10		*Knipowitschia caucasica*	Migrant	3,4	29,6	13,0	88,0
11		*Pomatoschistus sp.*	Resident	872,3	1261,7	537,3	1495,8
12		*Zosterisessor ophocephalus*	Resident	5,6	0,8	11,3	8,3
13	MORONIDAE	*Dicentrarchus labrax*	Migrant				0,5
14	MUGILIDAE	*Chelon labrosus*	Migrant	0,6		0,8	2,5
15		*Liza aurata*	Migrant	188,8	1,7	7,5	6,5
16		*Liza ramada*	Migrant	73,6		2,5	3,3
17		*Liza saliens*	Migrant	88,1	28,3	52,3	100,5
18		*Mugil cephalus*	Migrant	154,5	0,8	0,8	8,5
19	MULLIDAE	*Mullus surmuletus*	Straggler				
20	PLEURONECTIDAE	*Platichtys flescus*	Migrant	0,2			
21	POECILIIDAE	*Gambusia affinis*	Resident	4,2			14,5
22	SCIAENIDAE	*Sciaena umbra*	Straggler			0,3	
23	SCOPHTHALMIDAE	*Scophthalmus rhombus*	Straggler	0,2			
24	SOLEIDAE	*Solea sp.*	Migrant	0,2			
25	SPARIDAE	*Diplodus annularis*	Migrant	0,5		2,8	0,5
26		*Diplodus puntazzo*	Migrant	0,2		0,8	
27		*Diplodus sargus*	Migrant			1,0	
28		*Diplodus vulgaris*	Migrant	2,5			0,5
29		*Lithognathus mormyrus*	Migrant				0,3
30	SPHYRAENIDAE	*Sphyraena sphyraena*	Straggler				
31	POMATOMIDAE	*Pomatomus saltatrix*	Straggler			0,3	
32	SYNGNATHIDAE	*Hippocampus sp.*	Straggler			1,3	
33		*Nerophis ophidion*	Straggler	0,2			
34		*Syngnathus abaster*	Resident	14,2	1,7	4,5	6,5
35		*Syngnathus acus*	Migrant				0,5
36		*Syngnathus typhle*	Resident	2,8			

References
1 - Koutrakis E.T., A.K. Kokkinakis, A.E. Eleftheriadis & D.M. Argyropoulou., 2000. Seasonal changes in distribution and abundance of the fish fauna in the two estuarine systems of Strymonikos Gulf (Macedonia, Greece). *Belgian Journal of Zoology*, 130: 41-48.
2 - Sylaios G. & Theocharis V., 2002. Hydrology and Nutrient Enrichment at Two Coastal Lagoon Systems in Northern Greece. *Water Resources Management*, 16: 171–196.

TROPHIC CONDITION IN THE BOKA KOTORSKA BAY

Sladjana Krivokapic [1]*, Branka Pestoric [2], Suncica Bosak [3] and Grozdan Kušpilic [4]
[1] *Department of Biology, Faculty of Science, University of Montenegro, Montenegro - sladjana69@yahoo.com
[2] Institute of Marine Biology, Kotor, Montenegro
[3] University of Zagreb, Faculty of Science, Division of Biology, Zagreb, Croatia
[4] Institute of Oceanography and Fisheries, Split, Croatia

Abstract

Two indicators of the trophic state, TRIX index and Fp ratio, for the first time were used to assess trophic conditions in the Boka Kotorska Bay. The TRIX value in this area ranged from 3.02 to 5.58 (4.11 ± 0.66) while the values of the Fp ratio varied between 0.05 and 0.33 (0.17 ± 0.08). The results indicated that the study area corresponds to a "good" trophic state, with moderately productive waters.

Keywords: Adriatic Sea, Eutrophication

Introduction

The inner part of Boka Kotorska Bay, where our research took place, is a relatively shallow, semi-enclosed Bay strongly influenced by freshwater discharge. This input, together with sewage discharge and agriculture runoff, causes nutrient enrichment and eutrophication which can lead to highly undesirable changes in ecosystem structure and function. One of the principal effects of the enhanced nutrient concentration is a massive increase in primary productivity. Vollenweider [1] has defined a trophic index (TRIX) based on chlorophyll *a*, oxygen saturation, dissolved inorganic nitrogen and total phosphorus to characterize the trophic state of coastal waters. Claustre [2] has defined the Fp ratio which indicates the variability of the phytoplankton community i.e. the influence of environmental conditions on the phytoplankton community. The aim of this study was to apply trophic index TRIX and Fp ratio for assessment of the trophic state of the Boka Kotorska Bay.

Material and methods

Seawater samples were taken seasonally from April 2008 to March 2009 at three stations in the inner part of the Boka Kotorska Bay. Temperature, salinity and oxygen concentrations were measured *in situ* by multi Line P4-Universal Meter. Concentrations of nutrients were measured on unfiltered water samples using standard colorimetric methods [3]. The qualitative and quantitative analyses of pigments in the water samples were determined using HPLC method [4]. The Fp ratio was calculated as described by Claustre [2] using pigment concentrations while the trophic index TRIX was calculated according Vollenweider et al. [1].

Results and discussion

Temperature followed changes in seasonal insolation, with minimum value measured in winter (10.70 ºC) and maximum in summer (27.90 ºC), both in the surface layer. Salinity was lower in spring because of rain and run-off with minimum value of 5.2 PSU in the surface layer, while maximum value was established in the bottom layer during winter (37.0 PSU). Oxygen ranged from minimum saturation in winter (61%, 2m below the surface) to its maximum in summer (114%) in the 5m below surface layer where also high phytoplankton production has been established.

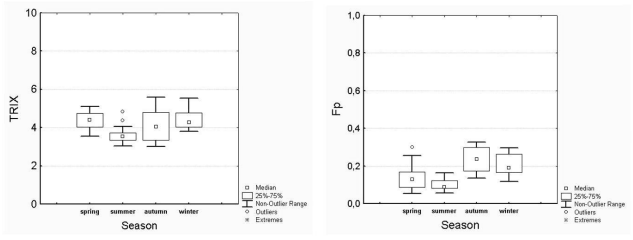


Fig. 1. Box & Whisker representation of seasonal TRIX and Fp index in inner part of the Boka Kotorska Bay

Chlorophyll *a* concentrations were found often enhanced after rainfall, which indicates to the importance of diffusive nutrient inputs for the ecosystem in the Bay. The highest N:P ratio (199) was detected in the same period on surface that can indicate to P limitation common in the Mediterranean [6] and the Adriatic sea [7].

According to chlorophyll *a* concentration and the criteria of Håkanson the area could be described as oligo-mesotrophic. The TRIX values (Figure 1.) in this area ranged from 3.02 to 5.58 (4.11 ± 0.66) while the values of the Fp ratio varied between 0.05 and 0.33 (0.17 ± 0.08). According to TRIX classification criteria, the mean seasonal value between 4 and 5, investigation area corresponds to good trophic state, moderately productive waters with occasional water turbidity, anomalous water colors and bottom water hypoxia episodes. Values of TRIX and Fp were similar as in Gulf of Trieste [5] and northern Adriatic [8] and indicated slight eutrophic conditions. Its seems that this two indicators are complementary, and we agree with Flander-Purtle and Malev suggestion [9] that in new TRIX tropic index it is neccessary to include also Chl *a* degradation products as an indication of the physiological status of the phytoplankton community.

Acknowledgement : This study was funded by the Norwegian Cooperation Program on Research and Higher Education with the countries on the Western Balkans: Marine science and coastal management in the Adriatic, Western Balkan. An education and research network (yrs. 2006-2009).

References

1 - Vollenweider R.A., Giovanardi F., Montanari G.,1998. Characterization of the trophic conditions of marine special reference to the NW Adriatic Sea : proposal for trophic scale, turbidity and generalized water quality index. *Environments*, 9: 329-357.

2 - Claustre H., 1994. The trophic status of various oceanic provinces as revealed by phytoplankton pigment signature. *Limnol Oceanogr*, 39: 1206-1210.

3 - Strickland, J. D. H. and T. R. Parsons., 1972. A practical handbook of seawater analysis. Bulletin. *Fisheries Research Board of Canada*, 167: 1-310.

4 - Mantoura R.F.C., Llewellyn C.A., 1983. The rapid determination of algal chlorophyll and carotenoid pigments and their breakdown products in natural waters by reverse-phase high-performance liquid chromatography. *Anal.Chim Acta*, 151: 297-314.

5 - Turk V., Mozetic P., Malej A., 2007. Overview of eutrophication- related events and other irregular episodes in Slovenian sea (Gulf of Trieste, Adriatic sea). *Ann, Ser. hist. nat.*, 17/ 2:197-216.

6 - Krom. M.D., Kress, N., Brenner, S., 1991. Phosphorus limitation of primary productivity in the eastern Mediterranean Sea. *Limnol. Oceanogr*., 36 (3): 424-432.

7 - Vukadin I.and Stojanoski, L., 2001. Phosphorus versus nitrogen limitation in the middle Adriatic Sea. *Rapp. Comm. int Mer Médit*., 36: 174.

8 - Pecar O. and Precali R., 2004. Long-term changes of the Northern Adriatic trophic conditions. *Rapp. Comm. int Mer Médit.*, 37: 234.

9 - Flander-Purtle V. and Malev A., 2003. The trophic state of coastal waters under the infuence of antropogenic sources of nutrients (fish farm, seawage outfalls) *Periodicum biologorum*, 105(4): 359-365.

THE CLIMATIC OPTIMA ASSESSED USING SEDIMENTS OF THE BLACK SEA

Eliso Kvavadze [1]* and Kakhaber Bilashvili [2]
[1] Iv. Javakhishvili Tbilisi State University, 0128 Tbilisi, Georgia
[2] Institute of Paleobiology, National Museum of Georgia, Tbilisi 380007, Georgia - e.kvavadze@yahoo.com

Abstract
The database for palynological studies of marine, lagoon, alluvial and bog sediments of the Black Sea coastline on the territory of Georgia includes 26 profiles of Holocene sediments. The analysis and synthesis of the plotted pollen diagrams allowed us to make a stratigraphic subdivision of Holocene sediments and to reveal climatic fluctuations for the last 10000 years. Most informative appeared to be pollen spectra of marine formations where there are no intervals and sediment accumulation.
Keywords: Black Sea, Sea Level, Paleoceanography, Sediments

Introduction

The palynological and sedimentological analysis showed, that the lowest level of the Black Sea occurred 18 – 17 thousand years ago. During this regression corresponding to the last phase of the Würm Ice Age the sea level was located 120m lower than at present. The cooling was replaced by the intensive warming, glaciers began to melt and a New Black Sea transgression began. By the onset of the Holocene (10 thousand years ago) the sea level increased nearly by 70 m [1]. According to the palynological data, the combination of vast number of pollen of heat-loving arboreal species which grow in lower mountain belts and low values of redeposited pollen are markers to reveal the Black Sea transgressive phases. On the contrary, during the Black Sea regression, the role of heat-loving elements decreases and there is a sharp increase in the quantity of secondary redeposited pollen caused by enhancement of erosion processes due to lowering of the general erosion basis. During the Holocene, transgressive phases with warm climatic conditions lasted longer than the regressive phases. The most significant warming and, accordingly, the sea transgression took place in the Atlantic period when during nearly three millennia (8000 - 5500 BP) the climatic trend was directed towards the increase both in precipitation and temperatures. This process reached its peak 6000 – 5500 years ago and the sea in Colchis for the first time for the whole post-glacial period exceeded by several meters the present-day level [2]. At the beginning of the Atlantic period, with establishment of humid and warm conditions, there appeared the first Neolithic agricultural settlements on the alluvial plains of Southern Kartli, where, besides grain-growing, gardening, viticulture, beekeeping and even weaving was developed. In the Eneolithic the warming process continued and mild climatic conditions facilitated the occurrence of new cultures and penetration of agriculture into the high mountains. The second significant ingression of the Black Sea waters took place at the end of the Subboreal period (3800 – 2400 years ago), which was also due to climate warming. The sea level again was higher than nowadays. Broad-leaved forests with participation of chestnut, lime, wing nut and dzelkva are expanding their areas. In high mountains stock-breeding is being replaced by agriculture where, besides grain-growing, viticulture and horticulture were developed. Trade might also have successfully developed, since in the archaeological monuments dated to the 15th – 14th cents. B.C., besides other imported inventory, cotton fabric and its numerous fibers were found. It is known that at that time cotton was manufactured only in India. The last 2000 geological years are characterized by more frequent transgressions and climatic fluctuations among which rather a long climatic optimum of the Middle Ages which lasted nearly for five centuries (7th – 11th cents.) is distinguished. The last warming and significant transgression of the Black Sea lasted for 200 years and took place in the 15th – 16th centuries. The influence of human activity on development of the landscapes had been observed since the Subboreal time when deforestation took place not only on the Colchis lowland, but also in the mountains of Western and Southern Georgia.

Conclusions

The comparison of the suggested scheme of climatic changes with similar schemes of mountain territories of the southern part of Europe and the Near East perfectly demonstrates the global character of climatic fluctuations resulting afterwards in oscillations of the level of the southern seas in Europe, including the Black Sea [3].

References
1 - Tvalchrelidze et al., 2004. Eustatics of the Black Sea and sedimentation peculiarities during the last 20 000 years (Georgian sector of the Black Sea). *Proc. of the Geolog.Inst, GAS new series* 119, 656-670.
2 - Kvavadze E.V., Connor S.E., 2005. Zelkova carpinifolia (Pallas) K.Koch in Holocene sediments of Georgia – an indicator of climatic optima. *Review of Palaeobotany & Palynology*, 133, 69-89.
3 - Grove J.M., 1997. The spatial and temporal variations of glaciers during the Holocene in the Alps,Pyrenees,Tatra and Caucasus. - In.:B.Frenzel (ed). Paleoklimaforschung/Palaeoclimate Research, Gustav Fischer Verlag.Stuttgart-Jena-Lubeck-Ulm, pp.95-103.

SPATIAL AND TEMPORAL ANALYSIS OF BACTERIAL DIVERSITY ASSOCIATED WITH THE MEDITERRANEAN GORGONIAN *PARAMURICEA CLAVATA*

Marie La Rivière [1]*, Joaquim Garrabou [2] and Marc Bally [1]
[1] Centre d'Océanologie de Marseille - UMR 6540 DIMAR, 13007, Marseille, France - marie.la-riviere@univmed.fr
[2] Institut de Ciències del Mar - CSIC, 08039 Barcelona, Spain

Abstract
We combined terminal-restriction fragment length polymorphism (T-RFLP) and clone library analyses to investigate the diversity and the spatio-temporal changes of bacterial assemblages associated with the gorgonian *Paramuricea clavata*. We found a clear difference between the bacterial communities during winter and summer while T-RFLP profiles were highly similar between *P. clavata* populations separated by hundreds of kilometres. Sequencing data from 16S rDNA clone libraries demonstrated the presence of distinct phylogenetic taxa during summer and winter, with an increased diversity in the warm season. In the context of recurrent gorgonian diseases and mortalities, this picture of the structure of bacterial communities will be helpful to monitor the effects of thermal anomalies on the resident microbial flora.
Keywords: Bacteria, Cnidaria, Mortality, Western Mediterranean, Global Change

Introduction
Mass mortality outbreaks in coastal ecosystems have considerably increased during the past few decades affecting in particular marine invertebrates [1]. In the Northwestern (NW) Mediterranean, recurrent mass mortalities have affected benthic macroinvertebrate species such as gorgonians, sponges and bryozoans. The environmental driver of these large-scale events was an increase in seawater temperature during temperature anomalies in summer [2]. From diseased *P. clavata* colonies, we previously isolated a *Vibrio coralliilyticus* strain that showed thermodependent virulence during controlled infection experiments in aquaria, supporting the involvement of bacterial pathogens in gorgonian die-offs [3]. We hypothesized that variations in specific composition of bacteria associated to *P. clavata* at elevated temperature could be used to detect potential pathogens prior to apparition of disease signs, and might help identify causal agents. However, composition and dynamics of the natural microbial communities living in association with temperate gorgonians are unknown. The main aim of this study was to establish a baseline for diversity and abundance of the bacterial community of *P. clavata*.

Material and methods
Three sampling sites were chosen along the NW Mediterranean coast: Riou Island (gulf of Marseilles), Medes Island (Catalan coast) and Scandola (NW Corsica). For each site, apical branch tips of 3 *P. clavata* colonies were collected at a depth of 20 m, in march 2007, july 2007 and february 2008. Three liters of seawater were also collected and filtered for analysis of planktonic bacteria. For T-RFLP analysis, bacterial 16S rDNA was amplified from total genomic DNA by PCR using fluorescent-labeled universal primers. PCR products were digested by restriction endonucleases *Cfo*I and *Msp*I and separated on an ABI 3130 Genetic Analyzer (Applied Biosystems). The terminal restriction fragments (T-RFs) data collection for each sample was converted into a binary matrix which was used for metric multidimensional scaling (MDS) analyses. Clone libraries were generated by amplification of 16S rDNA using unlabeled primers and subsequent cloning in pGEM-T vector (Promega). Sequences were compared to 16S GenBank database using the Blast program.

Results and discussions
The T-RFLP profiles of bacterial 16S rDNA obtained from three independent *P. clavata* colonies sampled at the same site were highly similar, suggesting that gorgonians maintain a conserved microbial population. Comparison of profiles obtained from Riou, Medes and Scandola further indicated that bacterial communities were very similar between geographically remote *P. clavata* populations. In agreement with a bacterial-gorgonian interaction, no overlap was found between T-RFLP profiles of bacterial communities of *P. clavata* and those of the surrounding seawater. Seasonality in bacterial diversity was investigated by the analysis of *P. clavata* colonies sampled at the three study sites in the winter and the summer of 2007. T-RFLP data showed that species composition differed greatly between the two seasons. Furthermore, no significant differences in bacterial communities were found between samples from winter 2007 and winter 2008. Ordination by MDS supported clustering of bacterial assemblages by seasons, and confirmed that *P. clavata* colonies from different areas of the NW Mediterranean harbor closely related microbial flora (Fig. 1).

Bacterial 16S rDNA clone libraries were derived from *P. clavata* colonies sampled in winter and summer at the Riou site. The winter library was dominated by sequences of a unique bacterium (100% of the 88 clone sequences) affiliated with gamma-proteobacteria. The highest identity scores were obtained with *Spongiobacter*-related sequences (92%), previously retrieved from marine sponges. In summer, a larger diversity of bacteria was detected and clone sequences were dominated by members of the Firmicutes (*Paenicillus sp.* and *Propionibacterium sp.*, accounting for 86% of the 92 clone sequences). Although the role of associations between bacteria and *P. clavata* is unknown, understanding how they change through time may represent a potential indicator of the gorgonian health status. Studies on tropical species of corals and gorgonians have demonstrated shifts in the microbial populations of affected colonies prior to visual signs of disease [4]. Thus, changes in the normal microbial community could serve as an early signal of stressful environmental conditions. We are currently looking for bacterial associations in different sympatric gorgonians (*Eunicella singularis*, *Eunicella cavolinii* and *Corallium rubrum*) to evaluate if related bacteria appear in different hosts. A similar pattern of host-microbe associations might reveal common mechanisms through which bacterial communities and gorgonian health are interlinked.

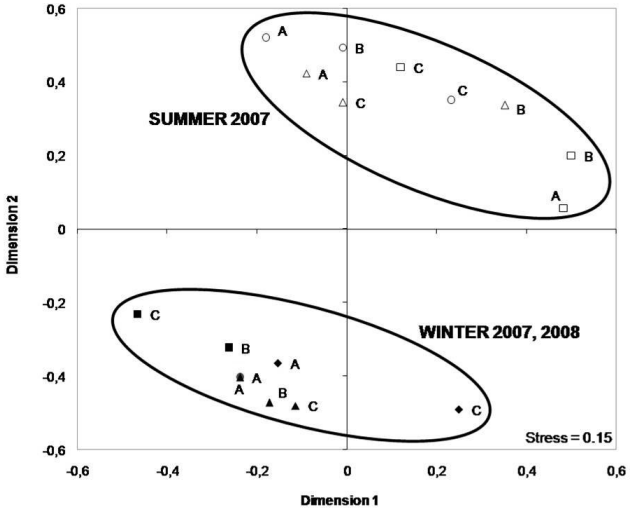


Fig. 1. MDS representation plot of the distances between T-RFLP profiles of Riou (square, diamond), Medes (triangle) and Scandola (circle) samples collected in summer (white) or winter (black)

References
1 - Harley C.D.G., Hughes A.R., Hultgren K.M., Miner B.G., Sorte C.J.B., Thornber C.S., Rodriguez L.F., Tomanek L. and Williams S.L., 2006. The impacts of climate change in coastal marine systems. *Ecol. Lett.*, 9: 228-241.
2 - Garrabou J., Coma R., Bensoussan N., Bally M., Chevaldonne P. *et al.*, 2009. Mass mortality in Northwestern Mediterranean rocky benthic communities: effects of the 2003 heat wave. *Glob. Change Biol.*, 15: 1090-1103.
3 - Bally M. and Garrabou J., 2007. Thermodependent bacterial pathogens and mass mortalities in temperate benthic communities: a new case of emerging disease linked to climate change. *Glob. Change Biol.*, 13: 2078-2088.
4 - Gil-Agudelo D.L., Myers C., Smith G.W. and Kim K., 2006. Changes in the microbial communities associated with *Gorgonia ventalina* during aspergillosis infection. *Dis. Aquat. Org.*, 69: 89-94.

FISHING EFFORT AND CATCHES IN THE MARINE PROTECTED AREA OF SCANDOLA AND ADJACENT AREAS (CORSICA, MEDITERRANEAN)

Laurence Le diréach [1], Patrick Bonhomme [1], Charles f. Boudouresque [2]* and Gwenaël Cadiou [1]
[1] GIS Posidonie, Centre d'Océanologie de Marseille
[2] Centre d'Océanologie de Marseille, Université de la Méditerranée - charles.boudouresque@univmed.fr

Abstract
The stability in the number of artisanal fishing boats and fishers, the relatively high yield (catch per unit effort ranging between 1.8 and 3.6 kg/100 m net) and the high commercial value of the targeted species, suggest that local fisheries are sustainable in the marine protected area of Scandola and adjacent areas.
Keywords: Fisheries, Marine Parks, Western Mediterranean

Introduction
The Scandola Marine Protected Area (MPA) was set up in 1975 (west coast of Corsica, western Mediterranean Sea). It includes a no-take area (72 ha) and a partially protected area (928 ha, mean depth 45 m) where professional fishing is allowed, but where recreational fishing (angling and spear fishing) and diving are forbidden. A survey of the fishing effort and catches within the MPA and in adjacent areas (Gulf of Ghjirulata southwards, Gulf of Focolara and Punta Scuglietti northwards) was started in 2000.

Material and Methods
Fishing gear was plotted on maps, on the basis of their GPS (Global Positioning System) position, at key periods of the fishing season (spring, summer and autumn). The catches were measured, weighed and identified on board by scientists embarked thanks to the cooperation of the fishers.

Table 1. Fishing effort and catches in the MPA of Scandola and adjacent areas. Gear = 100-500 m net. Spring = April-May, summer = July, autumn = September-October. ww = wet weight. n = number of sampled gear. md = missing data. n = number of data, SD=standard deviation.

Season and date	Mean number of fishing boats/ day (SD)	Mean number of gear/outing (SD)	Yield/boat/ outing, spiny lobster: kg ww (SD)	Yield/boat/ outing, fish: kg ww (SD)	Total yield/100 m net/outing: kg ww (SD) - n
Autumn 2000	7.0 (1.0)	22.8 (6.0)	md	md	md
Spring 2001	4.7 (1.4)	15.8 (5.3)	8.5 (5.8)	41.7 (27.7)	3.0 (4.0) - 34
Summer 2001	7.0 (0.9)	19.7 (4.6)	5.4 (5.1)	32.9 (15.4)	2.4 (2.0) - 29
Summer 2002	6.8 (2.1)	21.5 (6.8)	4.7 (3.9)	23.7 (27.1)	1.8 (2.1) - 58
Autumn 2002	5.8 (2.6)	14.1 (7.0)	md	md	md
Spring 2006	7.8 (1.5)	29.9 (11.4)	4.9 (6.3)	30.9 (26.0)	3.3 (2.9) - 67
Autumn 2006	5.1 (1.4)	19.3 (6.0)	4.5 (5.7)	31.7 (20.7)	2.2 (1.5) - 54
Autumn 2007	3.6 (1.8)	11.6 (7.8)	md	24.2 (17.6)	3.6 (6.6) - 32

Results and discussion
At the study site, artisanal fisheries are characterized by seasonality (April to November) and small boats (11 m maximum) with only one fisherman onboard, using trammel nets and gill nets, targeting demersal and benthic fishes in spring and autumn, and spiny lobsters in summer. Catches are multispecific (61 species). The no-take area harbours relatively dense populations of protected species such as the teleost *Epinephelus marginatus* (grouper) and species of high commercial value such as the spiny lobster *Palinurus elephas*. Over the whole year, no increased fishing effort could be evidenced close to the limits of the no-take area. The fishing effort is higher near the shore, especially within the partially protected area in autumn when fishers are targeting *Mullus surmuletus* while spiny lobster fishing is banned, and in spring when they are targeting Sparids (e.g. *Dentex dentex*, *Spondyliosoma cantharus* and *Diplodus* spp.). The high commercial value of the spiny lobster was responsible for the summer seawards drift of the nets (near the 100 m depth line). In contrast with the general decline of the number of fishermen in Corsica and in other Mediterranean areas, the number of fishers and fishing boats has been stable in the study area over the past decades, in spite of increasing fishing effort (motor power and boat equipment). Overall, the yield (catch par unit effort: 100 m net) was relatively high (Table 1) in comparison with other Mediterranean areas (e.g. 0.8-1.5 kg/100 m net/outing, Strait of Messina [1]). In addition, most fished species are of high commercial value [2].These results suggest that local fisheries are sustainable.

The way in which the presence of the MPA and its management contribute to this sustainability, if they in fact do so, remains to be investigated. An increasing amount of data suggests that a positive role of the MPA constitutes a realistic hypothesis. In addition to contributing to our knowledge of artisanal fishery, the survey has encouraged co-operation between fishers and the MPA authority. Managers, as well as fishers, have become more aware that conservation objectives need not necessarily conflict with those of commercial exploitation, and may contribute to the sustainability of the fishery [2, 3].

References
1 - Potoschi A., Batttaglia P., Potoschi A. Jr and Rossi G., 2004. Rendimenti di pesca con reti "tramaglio" e "baldassone" su fondali invasi da Caulerpa taxifolia (Vahl) C. Agardh lungo le coste sicilianedello stretto di Messina. *Biol. Mar. Medit.*,11: 607-611.
2 - Cadiou G., Boudouresque C.F., Bonhomme P. and Le Diréach L., 2009. The management of artisanal fishing within the Marine Protected Area of the Port-Cros National Park (northwest Mediterranean Sea): a success story? *ICES J. Mar. Sci.*, 66: 41-49.
3 - Boudouresque C.F., Cadiou G., Guerin B., Le Diréach L. and Robert P., 2004. Is there a negative interaction between biodiversity conservation and artisanal fishing in a marine protected area, the Port-Cros National Park (France, Mediterranean Sea)? *Sci. Rep. Port-Cros Natl. Park*, 20: 147-160.

FISH FAUNA COMPOSITION AND ABUNDANCE IN TWO DIFFERENT ESTUARINE HABITATS IN THE IONIAN SEA

V. Liousia [1]*, S. Batziakas [1], I. Daouti [1], C. Genas [1], A. Oikonomou [1] and I. D Leonardos [1]
[1] Lab. of Zoology, Dep of Biological Applications and Technologies, University of Ioannina, Ioannina, Greece - vliousia@cc.uoi.gr

Abstract
Monthly changes of the estuarine fish fauna composition and abundance were investigated in two different habitats in the Ionian Sea. For each month, species richness was measured by the total number of species caught in each station, and the Shannon–Wiener diversity index was calculated. An ordination method (CA) was applied in order to examine the temporal presence of fishes in the studied ecosystems. Eutrophic conditions and type of vegetation influence the settlement and retention of fish in both stations.
Keywords: Ionian Sea, Biodiversity, Coastal Systems, Population Dynamics

Estuaries show high levels of habitat heterogeneity and support a large fish production due to the high nutrient levels in the bottom sediments and water column [1]. Estuarine ichthyofaunal assemblages have been extensively studied in many parts of the world [1,2], but the temporal distribution, abundance, seasonal diversity and the diversity indices of fish in Mediterranean estuarine systems is poorly known [3,4]. The aim of this study is to explore the monthly changes of the fish fauna composition and abundance in two different estuarine habitats in the Ionian Sea (Station I: Drepano in the Port of Igoumenitsa, Station II: Neohori in the Amvrakikos Gulf). Drepano is near the port of Igoumenitsa and has an open fetch in the sea. It is a part of Kalamas River estuarine ecosystem. The sea grass habitat of Drepano habitats compromises predominatly of *Zostera sp* providing a landscape of patchy seagrass amongst areas of bare sand. Amvrakikos Gulf is a shallow semi-enclosed embayment in the Ionian Sea. It is connected with the Ionian Sea through a narrow channel (width 800 m, depth 12 m). The seagrass habitat of Amvrakikos gulf comprises predominantly of dense *Posidonia oceanica* vegetation. Amvrakikos is one of the most eutrophic gulfs in Greece in contrast to Drepano which has very high water inflow. Fish species were collected in each habitat (station) on a monthly basis from July of 2008 to June of 2009 using a beach seine. Fish samples were preserved in 4% neutralized formalin solution and later identified to species level. For each month, species richness was measured by the total number of species caught in each station, and the Shannon–Wiener diversity index was calculated. In each station, the pattern of temporal changes in the structure of the overall fish community was explored by Correspondence Analysis (SPSS, Ver 17). In station I a total of 23.430 individuals were sampled, representing 39 species from 17 families. In Station II a total of 15.278 individuals were sampled, representing 26 species from 15 families. Species richness and diversity index varied significantly amongst habitats. Correspondence Analysis revealed a certain interaction between fish assemblage and seasonal changes in each station (Fig 1). In Station I in winter and spring the most dominant species belong to the families of Mugilidae, Sparidae and Labridae, in Summer the species of the Mulidae, Clupeidae, Atherinidae and Blenidae family dominate the ecosystem while in Autumn the species of the families Gobididae and Engraulidae are highly present. In Station II in Winter and Autumn the dominant species belong to the families of Gobididae and Atherinidae, in Spring in the families of Mugilidae and Atherinidae while in summer the species of the families of Syngnathidae, Blennidae, Sparidae and Cyptinodontidae are highly present.The highly eutrophic conditions and the dense foliage of the Amvrakikos Gulf are a limiting factor for the settlement and retention of fish in contrast to the oligotrophic conditions of Drepano.

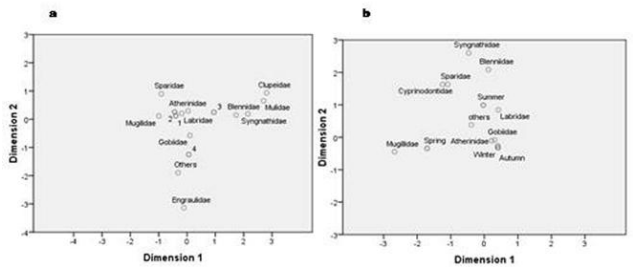


Fig. 1. Fish assemblage and seasonal changes ((1) Winter, (2) Spring, (3) Summer and (4) Autumn) in (a)Station I and (b) Station II

References
1 - Whitfield, A. K., 1983. Factors influencing the utilization of Southern African estuaries by fishes. S Afr *J Sci* 79: 362–365.
2 - Desmond, J. S., D. H. Deutschman, & J. B. Zedler, 2002. Spatial and temporal variation in estuarine fish and invertebrate assemblages: analysis of an 11-year data set. Estuaries 25: 552–569
3 - Leonardos, I. & A. Sinis., 1999. Population age and structure of Aphanius fasciatus Nardo, 1827 (Pisces: Cyprinodontidae) in the Mesolongi and Etolikon lagoons (W. Greece). *Fish Res* 40: 227–235.
4 - Mariani, S., 2001. Can spatial distribution of ichthyofauna describe marine influence on coastal lagoons? A central Mediterranean case study. *Estuar Coast Shelf* S 52: 261;267.

FUTURE SCENARIOS OF RIVER DISCHARGES OF WATER AND NUTRIENTS TO THE MEDITERRANEAN AND BLACK SEA

W. Ludwig [1]*, L. Bouwman [2], E. Dumont [3], F. Lespinas [1] and S. Heussner [1]
[1] Cefrem - UMR 5110 CNRS/ University of Perpignan Via Domitia - ludwig@univ-perp.fr
[2] Netherlands Environmental Assessment Agency
[3] Centre for Ecology and Hydrology

Abstract
The purpose of this paper is the development of future scenarios on the riverine inputs of water and nutrients to the Mediterranean and Black Sea. Based on detailed reconstructions of the river fluxes during the last 40-50 years, we identified their major controlling factors which were then used to project the budgets from the recent past into the near future. The modelling framework is given by the IMAGE model and its spatially explicit parameterisations of potential drivers, such as population growth, socio -economic development, land use changes and climatic boundary conditions. The future scenarios are based on the four scenarios for the years 2030 and 2050 developed within the Millenium Ecosystem Assessment.
Keywords: River Input, Global Change, Nutrients

Anticipation of future environmental changes is one of the major scientific challenges in Earth sciences. Two major drivers, commonly regrouped under the term of global change, are crucial for future ecosystem changes. The first is climate change, strongly acting through modification of the water cycle on Earth and its temporal variability. The second driver is demographic and socio-economic development, frequently accompanied by negative feedback on ecosystems services, e.g. through the massive release of pollutants and/ or the reduction of biodiversity. River discharges of water and associated elements are highly sensitive to both drivers, making them good indicators for global change in general. Moreover, as the fluxes represent a major link between the terrestrial and marine domains, they can be considered active players in the future evolution of the coastal ecosystems that closely depend upon river inputs.

The Mediterranean is one of the regions on Earth where global change is expected to cause considerable environmental impacts. The region has been identified as a "hot spot" for climate change. Many observation and modelling studies indicate that there is an ongoing trend towards warmer and dryer conditions, which is likely to continue in the future. On the other hand, the Mediterranean lies on the border of three continents, with different cultural, economical and political characteristics. This contrast is further enhanced when including the drainage basin of the Black Sea, because of the abrupt economical changes on the former USSR countries in the early 1990s. As a consequence, future demographic and economic development is expected to occur heterogeneously in this region, which may alter the spatial distribution of the actual environmental conditions. Exploitation of the coastal resources represents a major income for local populations, traditionally through fisheries and agriculture, and, as the Mediterranean has become the greatest tourist destination in the world, increasingly also via tourism. Therefore regional scenarios on the future evolution of river discharges to the sea are important to assess the potential impact of global change in the Mediterranean region, both in coastal waters and within the surrounding drainage basins.

The development of these scenarios is the purpose of our paper. Based on detailed reconstructions of the river fluxes during the last 40-50 years, we identified their major controlling factors which were then used to project the budgets from the recent past into the near future ([1], [2]). The quantitative framework of both the hindcasting and forecasting modelling scenarios is given by the IMAGE model and its spatially explicit parameterisations of potential drivers for the river fluxes, such as population growth, socio-economic development, land use changes and climatic boundary conditions. The future scenarios are consequently based on the four scenarios for the years 2030 and 2050 that were developed within the Millenium Ecosystem Assessment (MEA), and for which IMAGE produced the corresponding data layers.

We focussed on two contrasting parameters or parameter groups within the river fluxes. These are the fluxes of freshwater and the fluxes of nutrients, represented by nitrate and phosphate. Our results predict a significant trend of decreasing freshwater fluxes for the future, which already started in the past. Regional hot spots for this decrease are the drainage basins of the Alboran Sea and, when including the demographic evolutions, also the drainage basins of the Aegean and North-Levantine seas (Fig. 1). The predicted total nutrient fluxes to the Mediterranean and Black Sea remain in the envelope of the observed variability during the last 40 years. At regional scales, however, the budgets may considerably change. In the Mediterranean drainage basins of the North, such as the North-Western Basin and the Adriatic Sea, they uniformly tend to decrease. But in the basins of the South- and North-Levantine seas, where populations will grow rapidly, they may strongly increase. In the past, nutrient inputs from these two drainage basins were almost negligible in the total budgets, but they might become major components in the future.

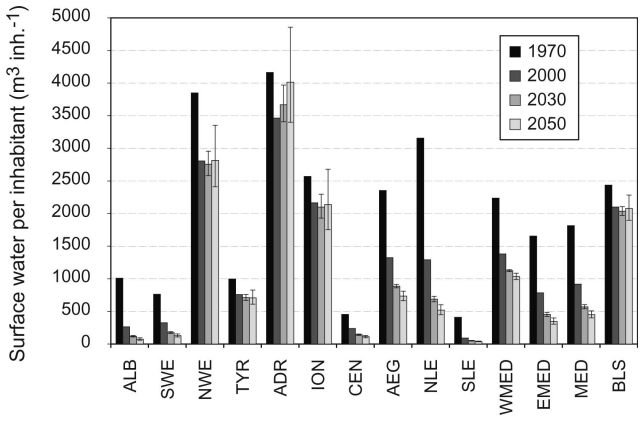


Fig. 1. Evolution of the population specific water resources in the drainage basin of Mediterranean and Black Sea. Standard deviation corresponds to the differences between the four future scenarios. The distinguished sub-basins are the Alboran (ALB), North-Western (NWE), South-Western (SWE), Tyrrhenian (TYR), Adriatic (ADR), Ionian (ION), Central (CEN), Aegean (AEG), North-Levantine (NLE), and South-Levantine (SLE) seas. WMED, EMED, MED corresponds to the Western, Eastern and entire Mediterranean Sea, and BLS represents the entire Black Sea

References
1 - Ludwig, W., Dumont, E., Meybeck, M., and Heussner, S., 2009. River discharges of water and nutrients to the Mediterranean Sea: Major drivers for ecosystem changes during past and future decades? *Progress In Oceanography*, 80, 199-217.
2 - Ludwig, W., Bouwman, L., Dumont, E. and Lespinas, F., submitted. Past and future trends in the river discharges of water and nutrients to the Mediterranean and Black Seas. Submitted to Global Biogeochemical Cycles.

ARTISANAL FISHING IN THE PROXIMITY TO A ROCKY LITTORAL MARINE RESERVE IN THE NORTHWESTERN MEDITERRANEAN: MEDES ISLANDS

Paloma Martin [1]*, Miquel Sacanell [1], Vanessa Stelzenmuller [2] and Francesc Maynou [1]
[1] CSIC-ICM - paloma@icm.csic.es
[2] CEFAS

Abstract
The fishing effort applied is low. Catches consist of most valued species and large- sized individuals. The creation of the reserve shifted the economic activity from fishing and agriculture to tourism.
Keywords: Marine Parks, Fisheries, Western Mediterranean

Introduction
The small archipelago of the Medes Islands consists of seven islets and a number of reefs situated scarcely a mile from the coast. The primary purpose of the marine reserve, created in 1983, is conservation, scientific research and ecotourism. Before 1983, trammel net, longline and spare fishing where common in the reserve. In addition, trawlers used to operate very close to the rocky grounds. The tourism-related activities, non- extractive uses, are by far the main economic activity in L'Estartit, the port whose fishermen traditionally used to fish in Medes Islands.

Methods
The Marine Reserve represents a total surface of 511 ha (emerged zone not included). It comprises an integral reserve (93 ha) and a buffer area (418 ha), where artisanal fishing can be practised. The geographical situation (center of Meda Gran Island is 42° 02' 55" N, 3° 13'30" E). Only fishermen from the very close fishing port of L'Estartit are allowed to go fishing into Medes Islands. On board sampling (2003- 2005; 157 days at sea; 7 different vessels; 223 sets sampled; total weight sampled: 2600 kg; 107 species) allowed the identification of the fishing grounds, the characterization of the métiers (fishing gear, target species, seasonality) and corresponding catches (number and weight, by species); all fishes were measured (total length, mantle length, cm). Sampling allowed also the estimation of the discarded catch. Data for the winter months, when the fishing activity is at its lowest during the year because of weather conditions, were scarce, and thus, the characteristics of the métiers used in this season are not presented.

Results
Fishing can be practised 5 days a week, all year round, by the fishing boats based in L'Estartit. It is estimated that weather conditions allow go fishing around 120 days a year. In practice, the fishing effort applied is much lower. The fishing fleet is made up of 29 boats and the number of professional fishing licences is 15 (Generalitat de Catalunya, fleet census 2005). Of these, no more than ten go fishing all the year, and only three-four fishermen go routinely into the buffer zone. Trammel net and longline are the fishing gears allowed in the buffer area. A fisherman uses different métiers, thus, the characteristics of the vessels, by métier, are similar (lengh: 6 m; horsepower: 40 hp; age: 25 years). Most fishing activity concentrates in an area of around 4 km from the reserve border, mainly within 2 km from the reserve border. The seasonality regarding the target species and use of fishing gears is typically Mediterranean. Daily catches (total, landings and dicards) by fishing gear are given in Table 1. The specific composition by métier, expressed as percentage of the total catch (species representing >5% of the total catch; winter data not included) was as follows: trammel net targeting *Mullus surmuletus* (*M. surmuletus* (27%), *M. cephalus* (23%), *P. acarne* (16%), *Diplodus sargus* (5%)); longline targeting *Sparus aurata* (*S. aurata* (80%), *Dicentrarchus labrax* (16%)); gillnet targeting *Pagellus erythrinus* (*P. erythrinus* (35%), *Merluccius merluccius* (11%), *Pagellus bogaraveo* (10%), *Scomber japonicus* (8%), *Myliobatis aquila* (6%)); gillnet targeting *M. merluccius* (*P. erythrinus* (29%), *M. merluccius* (22%), *Lophius piscatorius* (9%), *S. japonicus* (8%)); traps targeting *Octopus vulgaris* (*O. vulgaris* (58%), *Conger conger* (34%)). The two gillnet métiers were differentiated taking into account the fishing grounds. The size distributions of the target species correspond to fishes significantly larger than those caught by similar fishing gears in areas not affected by protection regulations (Fig. 1). The most discarded species was *Mugil cephalus*.

Tab. 1. Daily catch (kg) per vessel as estimated from the sampling on board, for the total catch, landings and discards. The number of sampling days is also indicated

	tot (kg)	comm(kg)	disc(kg)	fishing days
all gears com	16,5 ±20,8	14,7 ±19,7	1,8 ±4,2	150
gillnet	25,3 ±32,5	23,0 ±30,9	2,3 ±3,6	43
longline	15,2 ±13,2	13,9 ±12,7	1,3 ±4,6	44
trammel	12,3 ±11,7	10,3 ±10,2	2,0 ±4,6	54
trap	5,6 ±4,1	5,6 ±4,1	0,0 ±0,1	9

Discussion
Catches displaying the positive effects on fishing ([1], [2], [3]; this study) derived from the existence of the reserve (most valued species, large sizes), tourism-related activities drive the economic activity (for example, more than 60.000 scuba dives and around 200.000 tourists in cruises around Medes Islands per year).
The information collected on board on the fishing activity and resources exploited in the area around Medes Islands marine reserve can be taken as reference point to assess the evolution of these resources.

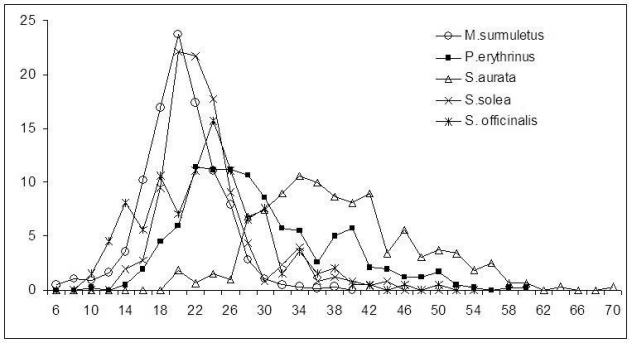


Fig. 1. Size distribution expressed in percentage (total length, mantle length, cm)

References
1 - Stelzenmuller V., Maynou F. and Martín P., 2009. Patterns of species and functional diversity around a coastal marine reserve: a fisheries perspective. Aquatic Conserv: *Mar. Freshw. Ecosyst*., 19: 554-565.
2 - Merino G., Maynou F. and Boncoeur J., 2009. Bioeconomic model for a three-zone Marine Protected Area: a case study of Medes Islands (northwest Mediterranean). ICES *J.Mar.Sci*., 66: 147- 154.
3 - Stelzenmuller V., Maynou F. and Martín P., 2007. Spatial assessment of benefits of a coastal Mediterranean Marine Protected Area. *Biol. Con*. 136: 571-583.

A SCALE FOR MEASURING PEOPLE S OPINION ON THE VALUE OF WATER RESOURCES

Steriani Matsiori [1]*, Z. Stamkopoulos [1] and Ch. Neofitou [1]
[1] The Department of Ichthyology and Aquatic Environment University of Thessaly - steriani@uth.gr

Abstract
The opinion of visitors on the environmental values of the river Penaeus (central Greece) was investigated. All types of environmental values were studied. The methodology that was employed for the development of measurement scales, was a combination of applied methodological research techniques in marketing research. More specifically, evaluation of a-Cronbach, Principal Component Analysis with Varimax rotation were used in order to assess the internal consistency and construct validity of the used scale.

Keywords: Economic valuation, Ecosystem services, Intermediate Waters

Introduction

The expression of total economic value (TEV) is an attempt to express the motivations behind people's preferences for environmental assets and the services these resources provide. The TEV provides a framework, to comprehensively evaluate natural and environmental resources [6]. The TEV is used in environmental economics to divide an environment into different components of value [6]. The mechanisms that link resources to individual and community well being, are the direct use of natural resources (for example, commercial and non-commercial recreation), the indirect use of a resource (i.e. ecosystem function values such as protection of biodiversity) and the non-use (such as the preservation of natural ecosystems, species or special areas) [7]. Economists divide use values into three main categories: direct, indirect and option values [4]. *A* type of option value is *quasi-option value* that has been described as the value ofpreserving options for future use given same expectation of the growth of knowledge [2]. On the contrary non-use values can be divided further into existence, bequest, and option values [5]. For many economists the option value may be classified as use value because is clearly connected to potential use (direct or indirect) and it is considered as unnecessary with the argument that it derives from the real use [9]. The existence value and the bequest value have not functional significance, for [8] existence value should not be used in cost-benefit analysis. The main objective of this paper is to investigate the existence of all type of environmental values and to examine who people perceive or recognize them in practice.

Materials and methods

The present research was carried out in the Penaeus River (central Greece), one of the most important aquatic ecosystem of Greece. Target population was visitors of the region. The socio-economic profile of survey sample (246 valid questionnaires) is given in Table 1.

Tab. 1. Socioeconomic profile of survey sample

Sex	53.3 % (Men)
Age	29-30 (33.75%)
Education level	Higher education (18.7%)
Occupation	Office Employee (21.1%)
Monthly income	900-1200 (17.1%)

The lack and the weakness of creating a sampling frame before the beginning of the study had led to the selection of the cluster sampling method [1]. A questionnaire was developed to determine all the types of environmental values. For this purpose every type of environmental value was described by a number of motives according to [7] and 47-attribute scale was derived to measure the value of the destination area. A five point Likert scale was used to measure visitor's opinions [3]. Evaluation of a-Cronbach and Principal Component Analysis with Varimax rotation were used in order to assess the internal consistency, construct validity of the used scales, classify types of values and investigate the motives that influence people to value a water resource. The identification of factors that describe the involved variables was performed by the orthogonal rotation method or the Varimax method. For determining the factors that were drawn it was used the eigenvalue or the characteristic root criterion (eigenvalue $\geqslant$1) [1].

Results and Discussion

The principal components analysis gave 6 factors that explain the 72.37% of total of the total variability (Table 2). Only 4 of them can be explaining people's opinions for river value. The Bartlett's test of sphericity has shown that there is high statistical significance (x^2=8.293,97, p=0.000 and d.f.=990) and shows that the factor analysis model is suitable for our data. Kaiser – Mayer – Olkin (KMO) value shows that the measure of sampling was suitable (0.94). Reliability analysis of the scale revealed that a-Cronbach was 0.98. Examining corrected item-to-total correlation and value of coefficient alpha if item deleted, no items were found that would increase coefficient alpha significantly (>0.01), so all items retained. It is very From the results, the people do not distinguish the deference between direct and option value. The use value (direct and option), was the most important type (50.34%) and follows by the existence value (10.75%). This is in accordance to many economist's opinions which suggests that it is value of assuring future direct or indirect use [9]. According to survey results people has an anthropocentric consideration of the environment and their attribute and give more significance to instrumental value of them. The results of our research shows that people recognize most of the different types of environmental values but classification high use values. Types of values like quasi-option value can not be noticeable. The results confirm the opinion of many environmental economists who claim that we put only instrumental value to the environment and natural resources.

Tab. 2. Principal components analysis results

Factors	Identification	Mean score per Factor	Explanatory Dispersion %	a-Cronbach
F1	Use value (Direct and option value)	3.3293	50.345	0.964
F2	Existance value	2.8690	10.748	0.934
F3	Indirect use value	3.0348	3.426	0.935
F4	Bequest value	3.0263	2.969	0.8484

References

1 - Aaker, D., Kumer, V., Day, G., 1995. Marketing Research. Fifth Edition. New York: John Wiley & Sons.
2 - Arrow, and A. Fisher., 1974. Environmental Preservation, Uncertainty and Irrepressibility. Quarterly Journal of Economics, 98: 85-106.
3 - Babbie, E. , 1989. The Practice of Social Research, 5th ed. Belmond, CA: Wadsworth Publishing.
4 - Diamond, P.A. and J.A. Hausman., 1994. Contingent Valuation: Is Some Number? *Journal of Economic Perspectives* 84, 455-64.
5 - Georgiou, S, D. Whittington, D. Pearce, D. Moran., 1997. Economic values and the environment in the developing word. Cheltenham. Glos, UK.
6 - Pearce, D. and D. Moran., 1994. "The Economic Value of Biodiversity", Earth scan Publications Limited, London, UK.
7 - Pearce, W.D., and K.R. Turner., 1990. Economics of Natural Resources and the Environment. Harrester Wheatsheaf.
8 - Rosenthal, D.H. and R.H. Nelson., 1992. Why Existence Value Should Not Be Used in Cost – Benefit Analysis. *Journal of Policy Analysis and Management* 11(1), 116-122.
9 - Tryfos, P., 1996. Sampling Methods for Applied Research text an cases. John Wiley & Sons, Inc. Canada.
10 - Kolstad C.D., 2000. Environmental Economics. New York. Oxford University Press.

EUTROPHICATION INDICATORS IN THE NORTHWEST COAST OF THE ALBORAN SEA: A MULTISCALAR TIME ANALYSIS

Jesús m. Mercado [1]*, Dolores Cortés [1], Teodoro Ramírez [1] and Esperanza Liger [2]
[1] Instituto Español de Oceanografía, Centro Oceanográfico de Málaga - jesus.mercado@ma.ieo.es
[2] University of Málaga

Abstract
A time series of hydrology, nutrients and chlorophyll a during 1992-2007 was analysed to study the influence of the hydrological dynamics and nutrient pollution on the trophic state of a coastal station located at the bay of Málaga. The results indicate that water quality has improved during the last decade.
Keywords: Alboran Sea, Eutrophication, Phytoplankton, Nutrients, Time Series

Introduction
The link between anthropogenic sources of nutrients and eutrophication symptoms in coastal areas is generally accepted. However, the analysis of time series reveals that the coastal systems respond in various different ways to nutrient enrichment. This variety of responses is due to physical and/or biological attributes that together act as a filter to modulate the response to the signal of change in nutrient loading. Furthermore, the simultaneous operation of other stress factors (including the climate system) influences all the signals and the filters. The availability of nutrients in the northwest sector of the Alboran sea is strongly influenced by quasi-permanent upwelling of enriched deep water associated to the hydrological structures generated by the Atlantic jet that penetrates through the Strait of Gibraltar. Additionally, the wind regime regulates the intensity of the upwelling. The objective of this work is to study how these hydrological constrains may contribute to modulate the response to nutrient enrichment of the coastal ecosystem in the bay of Malaga .

Methods
One station located close to the bay of Málaga was sampled each three months from october-1992 to february-2007. During each visit, the Secchi disc depth was determined and vertical profiles of temperature and salinity were obtained. Additionally, water samples for nutrients and chorophyll a (chl a) analysis were collected at 0, 10 and 20 m depth. Nitrate and phosphates and chl a concentrations were analysed according to the methods detailed in [1]. TRIX index was calculated according to [2]. The seasonal variability patterns were tested by determining the statistical significance of the differences among seasonal means. An exponential smoothing of the seasonally adjusted series was performed in order to remove high-frequency component of variability (residuals series). Inter-annual change patterns and linear trends over time were examined by analysing the smoothed series. The significance of the monotonous trends over time was tested by fitting the smoothed series to a linear model.

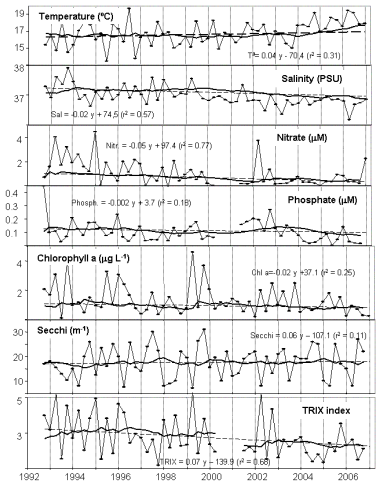


Fig. 1. Seasonally adjusted and smoothed time series of different measured variables. The dotted line indicates the linear trend calculated by least square fit of the trend component time series.

Results
The annual maxima of temperature were obtained in summer, and salinity and nitrate peaked in spring. Nitrate concentration averaged for summer-period was reduced 5-fold with respect to the spring period. In contrast, phosphate concentration did not follow a defined seasonal cycle. The temperature described a linear monotonous increase trend over time (Fig. 1). The linear time trends for the salinity, nitrate and phosphate were also significant although negative. The residuals series of temperature and salinity were significantly correlated ($r = -0.55$, $p < 0.05$). However, there was not correlation between residuals series of salinity and nitrate or phosphate. Chl a concentration and Secchi disc depth did not describe any clear seasonal variation pattern, although normally higher chl a values were obtained in spring. Both variables experienced a monotonous decrease trend over the study period. Residuals of chl a were positively correlated with nitrate concentration ($r=0.35$ $p < 0.05$), however the correlation with phosphate was non-significant statistically. As obtained for nutrient concentrations and Chl a, TRIX index decreased over time.

Discussion
The study area is characterised by the presence of surface Atlantic water (AW) that is more or less modified depending on the degree of upwelling of deep Mediterranean water (MW). Therefore, the salinity decrease trend over time denotes a progressively lesser influence of the MW, as previously showed by [2] in other locations of the Alboran sea for the period 1992-2002. Atlantic water is usually depleted in nutrients. Consequently, the increasing influence of the AW produced a reduction of the nutrient concentration. Coincidently, chl a trended to decrease over time, indicating that the stock standing of phytoplankton at decadal scale was mainly controlled by the availability of nitrate. The high-frequency variability of chll a appears to be also controlled by the nitrate availability, as residuals series of both variables were significantly correlated. However, residuals series of nutrients were not correlated with salinity, probably indicating that the local peaks of nitrate and phosphate (which were especially conspicuous in 1992, 1994 and 2002) were not related with hydrological dynamics. It could be hypothesized that this high-frequency variability is due to nutrient discharge from terrestrial sources. The decrease trend over time of the TRIX index is a consequence of both the reduction of the nutrient and chl a concentrations (oxygen concentration did not experience any decadal variation pattern).

Acknowledgements : This work has been funded from the projects ECOMALAGA (IEO) and CTM2006-00426 and CTM2009-07776 (MICINN, co-funded from FEDER, EU).

References
1 - Mercado J.M., Cortés D., García A., Ramírez T., 2007. Seasonal and inter-annual changes in the planktonic communities of the northwest Alboran Sea (Mediterranean Sea). *Prog. Oceanog.* 74: 273-293.
2 - Vollenweider R.A., Giovanardi F., Montanari G., Rinaldi A., 1998. Characterization of the trophic conditions of marine coastal waters with special reference to the NW Adriatic Sea: proposal for a trophic scale, turbidity and generalized water quality index. *Environ.*, 9: 329-357

COMPARATIVE ANALYSIS OF GENETIC DIVERSITY OF BENTHIC SPECIES ACROSS THE NORTH-WESTERN MEDITERRANEAN SEA: A PILOT STUDY FOR MANAGEMENT PERSPECTIVES

B. Mérigot [1]*, E. Boissin [1], E. Egea [1], J. B. Ledoux [1], K. Mokhtar-jamaï [1], G. Penant [1], D. Aurelle [1], J. P. Féral [1] and A. Chenuil [1]
[1] Université Aix-Marseille II, Centre d'Océanologie de Marseille – UMR CNRS 6540 DIMAR; Station Marine d'Endoume, 13007 Marseille, France - bastien.merigot@univmed.fr

Abstract
Relative genetic diversity patterns of six marine benthic species are compared in a common set of areas in the north-western Mediterranean Sea. Genetic diversity of populations of two ophiuroids, two echinoids and two gorgonians is analysed in areas with contrasted environmental and anthropogenic conditions, ranging from Catalonia to the French Riviera. This study may provide a first step toward a broader multi-species analysis at larger scale in the Mediterranean Sea with implications for biodiversity management and protection.
Keywords: Biodiversity, Genetics, Coastal Systems, Western Mediterranean

The assessment of biodiversity within and among sites is central to identifying and prioritizing area for monitoring, management and protection. Genetic variation is widely recognized as one of several currencies for biodiversity evaluation ([1]), and protection of genetic diversity is incorporated into many national and international conventions. While previous works were mainly dedicated to study genetic diversity of populations of single marine species ([2], [3], [4]), no study until now compared relative genetic diversity patterns of distinct species in a common set of Mediterranean sites.

In this pilot study, the relative genetic diversity patterns of 6 benthic species are compared across areas ranging from Catalonia to the French Riviera in the north-western Mediterranean Sea (Fig. 1). The species studied are *Amphipholis squamata*, *Ophioderma longicauda*, *Echinocardium cordatum*, *Paracentrotus lividus*, *Corallium rubrum* and *Paramuricea clavata*. Some of these species are exploited by humans and threatened by the current regional warming of the Mediterranean Sea ([5]). These species have different dispersal abilities (eg. *Amphipholis squamata* does not dispose of a free larval phase in contrast to *Paracentrotus lividus*) and movement abilities (mobile versus fixed). As a result, distinct studies showed that some of them could be strongly structured at both local and regional scales (eg. *Corallium rubrum* [4]), while other species were structured only at large scale (eg. *Paracentrotus lividus* [2]). In this context, the selected areas (Catalonia, Blue Coast near Marseilles, Marseilles bay, Marseilles Calanques, French Riviera (Porquerolles island, Villefranche sur Mer, Monaco), Corsica island) allow to consider contrasted distance, environmental and anthropogenic influences on the studied species.

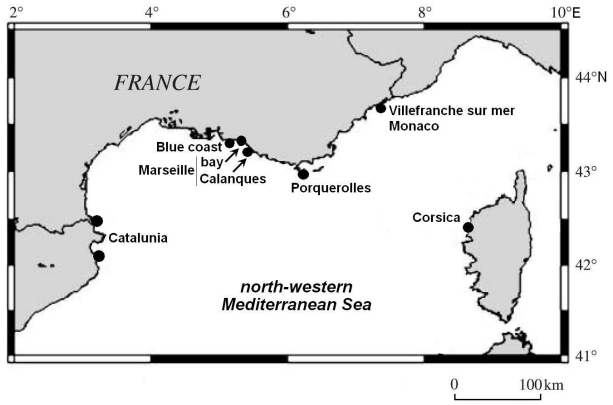


Fig. 1. Map of the commun areas for which relative genetic diversity patterns of distinct species are compared in the north-western Mediterranean Sea.

According to the species considered, sequences of two kinds of markers are analysed to investigate genetic diversity: mitochondrial DNA (ie. mitochondrial 16S rDNA and fragments of the mitochondrial gene coding for the subunit one of the cytochrome oxydase (mtCOI)), and nuclear DNA (ie. microsatellite loci). Genetic variability across populations in Mitochondrial DNA sequences and microsatellite loci, according to the species considered, are characterised by means of complementary diversity descriptors ([6], [7]).

Such an approach will allow to assess differences and/or similarities in genetic diversity patterns that hold across species and areas studied, and to discuss management perspectives.

References
1 - Humphries C.J., Williams P.H. and Vanewright R.I., 1995. Measuring biodiversity value for conservation. *Annu. Rev. Ecol. Evol. Syst.*, 26: 93-111.
2 - Duran S., Palacin C., Becerro M.A., Turon X. and Giribet G., 2004. Genetic diversity and population structure of the commercially harvested sea urchin *Paracentrotus lividus* (Echinodermata, Echinoidea). *Mol. Ecol.*, 13: 3317-3328.
3 - Costantini F., Fauvelot C. and Abbiati M., 2007. Genetic structuring of the temperate gorgonian coral (*Corallium rubrum*) across the western Mediterranean Sea revealed by microsatellites and nuclear sequences. *Mol. Ecol.*, 16: 5168-5182.
4 - Ledoux J.B., Mokhtar-Jamaï K., Roby C., Féral J.P., Garrabou J., Aurelle D. Genetic survey of shallow populations of the Mediterranean red coral (*Corallium rubrum* (Linnaeus, 1758)): new insights into evolutionary processes shaping current nuclear diversity and implications for conservation. *Submitted*.
5 - Garrabou J., Coma R., Bensoussan N., Bally M., Chevaldonne P., Cigliano M., Diaz D., Harmelin J.G., Gambi M.C., Kersting D.K., Ledoux J.B., Lejeusne C., Linares C., Marschal C., Perez T., Ribes M., Romano J.C., Serrano E., Teixido N., Torrents O., Zabala M., Zuberer F. and Cerrano C., 2009. Mass mortality in Northwestern Mediterranean rocky benthic communities: effects of the 2003 heat wave. *Global Change Biol.*, 15: 1090-1103.
6 - Nei M., 1987. Molecular Evolutionary Genetics. Columbia University Press, New York.
7 - Petit R.J., El Mousadik A. and Pons O., 1998. Identifying populations for conservation on the basis of genetic markers. *Conserv. Biol.*, 12: 844-855.

ETUDE BIOMETRIQUE DE *CAULERPA RACEMOSA* VAR. *CYLINDRACEA* (BRYOPSIDALES, CHLOROPHYTA) SE DEVELOPPANT SUR DIFFERENTS TYPES DE SUBSTRATS

Yosr Mezgui [1]*, Aslam Sami Djellouli [1], Amel Zerzeri [1] and Oum kalthoum Ben Hassine [1]
[1] Faculté des Sciences de Tunis, 2092, Tunisie - mezgui_yosr@yahoo.fr

Abstract
Dans la région de Cap Zebib (Nord de la Tunisie), *C racemosa* var. *cylindracea* se développe à la fois sur un substrat dur (roches) et sur un substrat meuble (sable). Des relevés mensuels des paramètres biométriques, réalisés selon un cycle de 13 mois, révèlent une variation cyclique marquée par une période de croissance optimale, située en automne, et par une période de disparition macroscopique totale des thalles, observée en hiver. D'autre part, les résultats montrent que le développement de l'espèce ne varie pas en fonction du substrat.
Keywords: Algae, Biometrics

Le complexe *C. racemosa* (Forsskål) J. Agardh n'est signalé que depuis peu en Méditerranée [1]. A partir des années 90, on note une extension rapide de l'espèce [2]. Verlaque [3] reconnaît en méditerranée 3 variétés de *C. racemosa* : (1) la variété *turbinata-uvifera*, (2) la variété *lamourouxii* et (3) la variété *cylindracea*. La variété *cylindracea* est considérée comme envahissante [3] et [4]. Elle est décrite, par ailleurs, comme colonisant différents substrats à différentes profondeurs et comme tolérant les températures hivernales, relativement basses, du Nord de la Méditerranée. Dans la perspective de contribuer à la connaissance du développement de la variété invasive, nous avons effectué une étude biométrique comparative, de deux peuplements de *C. racemosa* var. *cylindracea*, se développant sur deux types de substrats différents. Cette étude est réalisée dans la région de Cap Zebib (Nord Est de la Tunisie) où les peuplements de *C. racemosa* var. *cylindracea* se développent à la fois sur un substrat dur : roches (noté SI) et sur un substrat meuble : sable (noté SII). Ces deux stations sont situées à une profondeur moyenne de 0.3 m. Des prélèvements mensuels ont été effectués au niveau de chaque station durant une période de 13 mois, allant de juillet 2005 à juillet 2006. Les estimations mensuelles de la biomasse révèlent une période de disparition macroscopique totale des thalles de l'espèce en hiver. Puis, à partir du mois d'août, on assiste à une croissance de la biomasse des thalles qui atteint un maximum en automne, soit une valeur de 25 g/m^2 de poids sec au niveau de la station SI et 19,25 g/m^2 dans la station SII. Toutefois, le test de Kruskal-Wallis ne révèle aucune différence significative entre les deux stations (H = 90.75, p = 0.907).

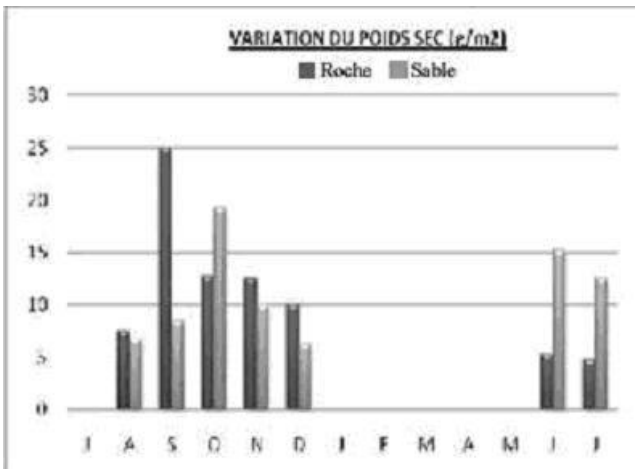


Fig. 1. Variations mensuelles du poids sec des populations à *Caulerpa racemos*a var cylindracea.

On note également que le diamètre des stolons reste constant et présente une moyenne égale à 1 mm (test ANOVA, F = 0.460, p = 0.501), au niveau des deux stations (SI et SII) et durant toute la période où un développement de l'algue est observé. En revanche, la longueur totale cumulée des stolons, nulle au mois de juillet, atteint son maximum (233,25 m/m^2 en SI et 120 m/m^2 en SII) en septembre. La longueur cumulée des stolons diminue progressivement par la suite pour aboutir à une disparition des thalles au mois de janvier. La longueur totale cumulée des stolons ne présente aucune différence significative entre SI et SII durant les 13 mois d'échantillonnage (Kruskal-Wallis test: H = 90.75, p = 0.907). Le nombre total moyen de frondes par m^2 atteint un maximum de 10 212 frondes/m^2 au niveau de SI et de 5 187.5 frondes/m^2 au niveau de SII. Le nombre de frondes ne présente aucune différence significative entre SI et SII (Kruskal-Wallis test: H = 84.3, p = 0.844). En conclusion, la croissance de *C. racemosa* var. *cylindracea* semble ne pas être influencée par la nature du substrat.

References
1 - Hamel G., 1926. Quelques algues rares ou nouvelles pour la flore méditerranéenne. Bull. du Muséum National d'histoire naturelle, tome 32, p. 420.
2 - Djellouli A., Langar H., and El Abed A., 1998. Le genre *Caulerpa* en Tunisie: situation actuelle. *Actes de l'atelier sur les espèces Caulerpa invasives en Méditerranée*, Heraklion, Crète, Grèce, 18-20 mars 1998: 217-223.
3 - Verlaque M., Durand C., Huisman J. M., Boudouresque C. F., and Le Parco Y., 2003. On the identity ane origin of the Mediterranean invasive *Caulerpa racemosa* (Caulerpales, Chlorophyta). *Eur. J. Phycol*, 38: 325-339.
4 - Verlaque M., Afonso-Carillo J., Gil-Redriguez M. C., Durand C., Boudouresque C. F. andLe Parco Y., 2004. Blitzkriez in a marine invasion: *Caulerpa racemosa* var. *cylindracea* (Bryopsidales, Chlorophyta) reaches the Canary Islands (NE Atlantic). *Biological Invasions 6:* 269-281.

SEAGRASS MONITORING BY REMOTE SENSING IN THE CONTEXT OF BIODIVERSITY CONSERVATION

C. Micheli [1]*, F. Borfecchia [1], L. De cecco [1], S. Martini [1], G. Ceriola [2], S. Bollanos [3], G. Vlachopoulos [3], L. M. Valiante [4], E. Fresi [5] and G. Campbell [6]

[1] ENEA Research Centre Casaccia C.P. 2400/000100, Roma, Italy - micheli@casaccia.enea.it

[2] Planetek, Via Massaua, 12-70123 Bari, Italy

[3] Planetek Hellas, Athens, Greece

[4] Ecol Srl, Napoli, Italy

[5] Università Tor Vergata, Lab. Acquacoltura ed Ecologia, Roma, Italy

[6] ESA European Space Agency, Frascati, Roma, Italy

Abstract

Remote sensing is a powerful tool in monitoring seagrasses, especially for managing the ecosystem. Along the coast, seagrass meadows are often subject to increased turbidity and may exhibit negative physiological responses to stress, or can tolerate it through photo-adaptation. Physiological changes are also evident in the genetic structure of meadows. This research aims at implementing a methodology for suitably monitoring mediterranean coastal ecosystem and, in particular, seagrasses, using an integrated and synergic approach. This consists of a more advanced remote sensing techniques and GIS technologies coupled with innovative methods for *in situ* measurements devoted to calibration of aero-spatial remotely sensed data. We investigated two sites: Central Tyrrhenian Sea (Italy) and the Aegean Sea (Greece).

Keywords: Posidonia, Remote Sensing, Physiology, Monitoring, Biogeography

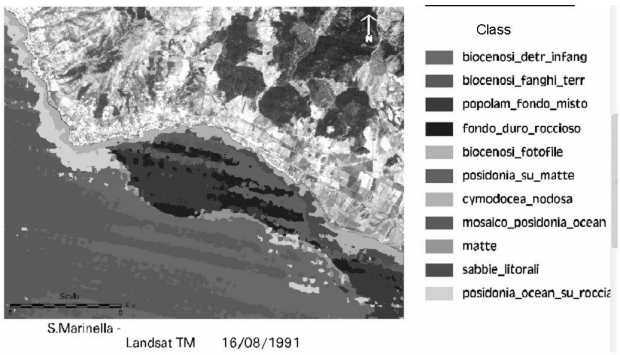


Fig. 1. Map of seagrasses distribution at S. Marinella site derived from Landsat-TM data of 1991.

INTRODUCTION

SIMS (*Seagrasses Integrated Monitoring System*) project is aimed at monitoring and mapping seagrass distribution and estimating the related biophysical parameters in two European areas. The goal of our project is to support different activities concerning customers' duties in terms of shallow water ecosystem management by means of Earth Observation data processing. Instead of using only laborious field collection methodology in a sometimes difficult environment, the project intends to provide customers with improved information, in line with other new technologies (i.e. GIS).

In this research we used satellite imagery as a tool for monitoring *Posidonia oceanica* meadows comparing two sites in the Mediterranean: the central Tyrrhenian Sea (Italy) and the Aegean Sea (Greece).

Tyrrhenian Sea.

The Tyrrhenian site is located off the central coast of Lazio region, close to the S. Marinella site. In this site some years ago research activities were started to monitor bio-physical parameters of *P. oceanica* meadows. Rhyzomes from the near zone of Civitavecchia were transplanted *in situ* to remediate seagrass lost .

Results of these multi-yearly ENEA's activities include the monitoring of meadows evolution in terms of phenological parameters and genetic trends [1, 2].

Maps of main seagrass beds at this test site were first developed by diving activity. Geo-referencing was done with careful measurements taken by means of cartography and bathimetry. This meadow presents a patchy distribution of *P. oceanica* plants in the entire coastal area, which extends for several kilometres. As can be seen in figure 1, the preliminary map obtained from Landsat-TM data of 1991 (even with some artefacts arising from the sensor low radiometric resolution) shows the distribution of the seagrasses in the area.

Aegean Sea

The second site is situated in the Aegean Sea, in East Greece, in the area around Arkoi island. Monitoring the Aegean sea by satellite images (IKONOS, LANDSAT, MERIS) allowed to track large areas of *P. oceanica* and seagrass beds in this part of the Mediterranean.

The framework of this project is satellite imagery used in combination with visual census data. This will lead to the development of a tool to quantify the size and the density of the seagrass meadows. Simultaneously seagrass biodiversity, both in Tyrrhenian and Aegean populations, will be evaluated by the RAPD molecular marker technique [1, 2].

The expected results are:

-to assess the role of environmental processes in shaping genetic diversity of seagrasses to identify molecular populations-specific RAPD patterns, from the combined studies of genetic variability and bio-chemical tests;

-to relate such patterns to environmental conditions and morphological and physiological features of the aquatic plants and to detect early process genetic erosion in stress conditions;

-to specify Remote Sensing and GIS procedures and bio-physical parameters/indicators thematic maps, designed to support sustainable management policies of Mediterranean ecosystems.

This research is financed by ESA: Project ITT No: AO/1-5828/09/I-EC

References

1 - Micheli C., Paganin P., Peirano A., Caye G., Meinesz A. and Bianchi C.N., 2005. Genetic variability of *Posidonia oceanica* (L) Delile in relation to local factors and biogeographic patterns. *Aquat. Bot.* 82: 210-221

2 - Micheli C., Borfecchia F., De Cecco L., Martini S., Spinosa S., Valiante L.M., Carannante F. and Fresi E., 2008. Genetica e mappe di telerilevamento satellitare nello studio di *Posidonia oceanica* di S. Marinella, Tirreno centrale. *In*: Micheli C. (ed.). Riunione Scientifica Annuale del Gruppo di Algologia. ENEA Publ. ISBN 88 8286 156-2, pp 31-32 .

THE CHANGING WATER BUDGET OF QUINTO BASIN (RAVENNA, ITALY) , A COASTAL WATERSHED UNDER CLIMATE CHANGE.

A. Minchio [1]*, M. Antonellini [1], G. Gabbianelli [1], M. Laghi [1], V. Marconi [1] and P. Mollema [1]
[1] University of Bologna (IGRG) - a.minchio@gmail.com

Abstract
The seasonal water budget of the Quinto Basin, a coastal watershed along the Adriatic sea in Italy, is calculated based on land use, under current and future climate conditions. Estimates of the future hydrologic surplus or deficit helps among others to understand whether salt water intrusion will be even a larger problem in the future than it is today, threatening both agricultural and natural ecosystems.
Keywords: Adriatic Sea, Coastal Processes, Global Change, Hydrology, Salinity

Introduction and study methods
We present the water budget of a small coastal watershed (The Quinto Basin, Ravenna, Italy) by calculating the seasonal evapotranspiration based on land use. For the farmland, wetlands, natural areas, pine forest and bare soil we use CROPWAT [1] with different crop factors to calculate the evapotranspiration (Etc). To reduce the number of calculations we selected the most common soils and crops (wheat, maize, alfalfa, peaches and grapes). Reed represents the vegetation in the wetlands. Open water evaporation on lakes and old quarries is also calculated [2]. The climate data used in this study is based on measurements from four local weather stations. For an estimate of future climate, the averaged output of fifteen GCM models, in two scenarios (A1b and A2) for the period 2079 - 2099 (IPCC, 2007) is used. In comparison with today, the minimum temperature will be higher whereas the maximum temperature is higher mostly in winter but will not increase considerably in summer. The total annual precipitation is thought to decrease from 635 mm to 619 mm (scenario A1b) or 596 mm (scenario A2) and relatively more rain will fall in winter. The humidity is predicted to be higher, the winds less strong in the future.

Results
The annual ETc values decrease under the future climate scenarios used for this study. However, since relatively more rain falls in winter (up to 64% for A2), the summer (April-September) water deficits increase considerably. Whether or not this results in an increase of irrigation requirement depends also on the soil type and planting date. All the crops on all types of soil will need more irrigation under A2 except Peaches and Wheat. Evaporation of open waters, wetlands and bare soil is decreasing since the futures higher humidity compensates for the higher temperatures.

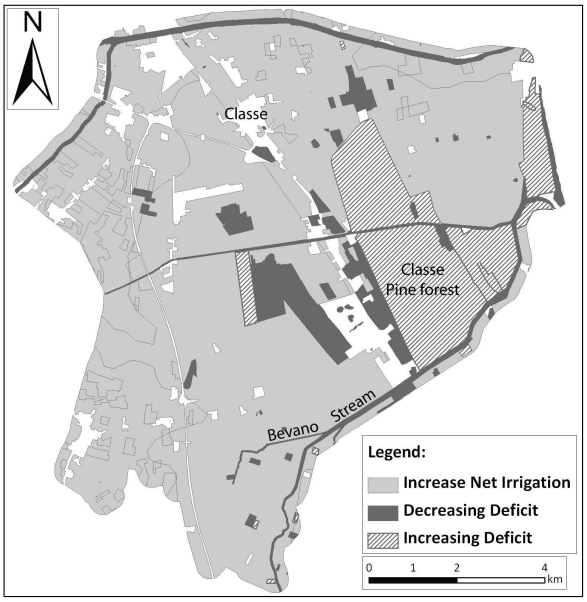


Fig. 1. The difference in annual net irrigation requirement between today and the future (scenario A2) for agricultural land, and the difference between current and future deficit (precipitation minus evapotranspiration) for the other areas.

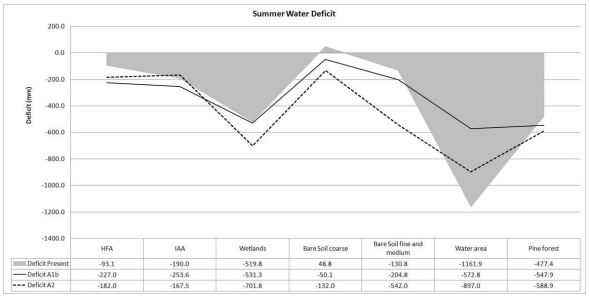


Fig. 2. Summer water deficit (mm) for present and for scenarios A1b and A2.

Discussion and conclusions
This study shows that air humidity and wind velocity has a large influence on (crop) evapotranspiration and evaporation of open water in the Quinto Basin. It is a parameter that is not often discussed in future climate studies but needs more attention. Summer water deficits will increase and therefore agricultural practices including planting dates should be reconsidered. Although we have an estimate of Pine tree transpiration, not much is known about current or future evapotranspiration of natural areas.

Acknowledgements This work is part of the WATERKNOW project funded by CIRCLEMED http://www.circle-med.net/ .

References

1 - Allen R.G, Pereira L. S., Raes, D, Smith M., 1998. Crop evapotranspiration. Guidelines for computing cropwater requirements. FAO Irrigation and drainage paper 56.
2 - Maidment D. R., 1993. Handbook of Hydrology. McGraw-Hill, Inc.
3 - IPCC., 2007: Climate Change 2007: Synthesis Report.

TENEURS EN HYDROCARBURES DANS DIFFERENTS PORTS DU GOLFE DE TUNIS, TUNISIE

N. Mzoughi [1], L. Chouba [1]*, Z. Souli [1], L. Hamdi [1] and R. M'rabet [1]
[1] Institut National des Sciences et Technologies de la Mer, La Goulette, 2060, Tunisie - lassaad.chouba@instm.rnrt.tn

Abstract
Dans le cadre d'un projet de recherche de l'INSTM, une étude sur l'état des lieux de la contamination par les hydrocarbures - sous ses différentes formes aliphatiques et aromatiques polycycliques (HAP) - dans différents ports selon leurs activités (passager, commerce, pêche et plaisance) a été réalisée. La collecte de trois échantillons d'eau de mer et de sédiments de chaque port a été réalisée au mois de mai 2008 et ce, dans différents ports du golfe de Tunis. Les concentrations les plus élevées en hydrocarbures dans les sédiments et dans l'eau sont enregistrées dans les ports de Radès et de Sidi Bou Saïd qui ont une activité maritime importante.
Keywords: Ph, Sediments, Pah

Les résultats des analyses effectuées ont révélé que les concentrations sont variables, entre 4,1 et 37,5 µg/g pour les hydrocarbures aliphatiques et entre 0,3 et 7 µg/g pour la somme des HAP dans les sédiments. Les teneurs trouvées dans les échantillons d'eau varient entre 0,25 et 5 µg/L pour les hydrocarbures aliphatiques et 0,15 et 7,1 µg/L pour les HAP. Les concentrations les plus élevées en hydrocarbures dans les sédiments et dans l'eau de mer sont enregistrées dans le port de Radès qui présente une activité commerciale importante et celui de Sidi Bou Saïd qui est caractérisé par ces activités de plaisances maritimes. L'analyse des données a montré une prépondérance des composés à 4 et à 5 noyaux par rapport à ceux à 2 et à 3 noyaux dans les trois ports. Cette différence peut être expliquée par la volatilité des composés à faibles noyaux aromatiques dans la zone d'étude, par l'évolution de la matière organique dans les sédiments et également par la courte durée de dégradation des précurseurs biogéniques. De manière générale, la présence ou non des hydrocarbures dépend de la géochimie du milieu et des structures chimiques (réactivités, volatilité, poids moléculaires, etc.) des composés.

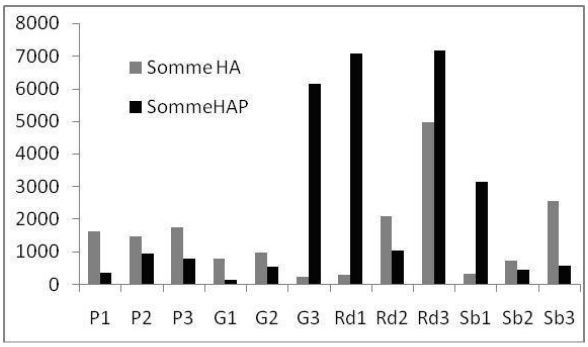


Fig. 1. Somme des hydrocarbures aliphatiques (HA) et aromatiques polycycliques (HAP) en µg/L dans des échantillons d'eau prélevés des trois ports de la Goulette (G et P), Radès (Rd) et Sidi Bou Said (Sb)

La figure 1 montre des concentrations variables en hydrocarbures, les teneurs les plus élevées sont observées dans la station G3 de la Goulette et les trois stations de Radès. La concentration des hydrocarbures aliphatiques est la plus prépondérante dans les sédiments des trois ports étudiés (figure 2). Cette prépondérance ainsi que la présence des complexes non résolus (UCM) obtenus dans les chromatogrammes des différents échantillons montre l'origine pétrolière de ces hydrocarbures [4].

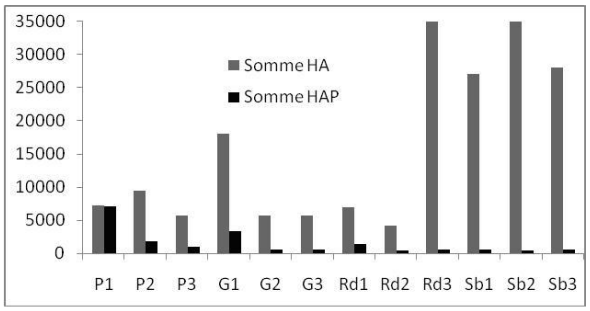


Fig. 2. Somme des hydrocarbures aliphatiques (HA) et aromatiques polycycliques (HAP) en µg/g dans des échantillons de sédiments prélevés des trois ports de la Goulette (G et P), Radès (Rd) et Sidi Bou Said (Sb).

D'une manière générale, l'augmentation de la concentration des hydrocarbures aliphatiques peut être expliquée par la production de ces composés (Digenèse) dans un milieu dépourvu d'oxygène.

References

1 - Villeneuve J.P., 1996. Cours de formation sur la determination des composes organochlorés et des hydrocarbures pétroliers dans l'environnement. IAEA-MEL/MESEL, pp 86.
2 - Miller J.S., 1999. Determination of polycyclic aromatic hydrocarbons by spectrofluorimetry. Analytica. *Chemica Acta*, 388: 27-34.
3 - Mzoughi N., Chouba L., 2005. Etude des micropolluants organiques et inorganiques dans les sédiments et les organismes marins du large du golfe de Gabès (Tunisie) *Phys. Chem. News 22* : 125-131.
4 - Mzoughi N, Chouba L. Lespes G. 2010. Assessment of total aromatic hydrocarbons, aliphatic and polycyclic aromatic hydrocarbons in surface sediment and fish from the Gulf of Tunis (Tunisia). *Soil Sediment Contam*, vol 19, n° 3 (In press).

ETUDE DU RYTHME LOCOMOTEUR D'ORCHESTIA MONTAGUI, ISSU DE LA LAGUNE DE BIZERTE (NORD TUNISIEN) EN CONDITIONS D'ENTRAINEMENT ET EN LIBRE COURS

Karima Nasri-Ammar [1]* and Raja Djelassi [1]

[1] Unité de recherche Biologie animale et systématique évolutive, Faculté des Sciences de Tunis, 2092 Tunisie - knasri@planet.tn

Abstract

Le rythme de l'activité locomotrice de l'Amphipode supra littoral *Orchestia montagui* a été enregistré au niveau de la population de Bizerte (Nord de la Tunisie). L'étude de la variation saisonnière des caractéristiques du rythme locomoteur a montré une période circadienne et un temps d'activité plus longue et plus étendu en été qu'en hiver. Par ailleurs, l'étude du rythme de l'activité locomotrice des animaux expérimentés a révélé l'existence d'une composante ultradienne de période égale à 12h et ceci quelle que soit la saison.

Keywords: Crustacea, Behaviour, Lagoons

Introduction

Les rythmes biologiques constituent une réponse adaptative permettant aux organismes vivants de maximiser leur gain d'énergie et d'optimiser leur chance de survie, d'où l'importance de la synchronisation de l'activité locomotrice par les facteurs environnementaux, considérés comme des entraîneurs. En effet, plusieurs recherches ont montré que la photopériode constitue un puissant synchroniseur de ce comportement [1], [2] et [3]. Le but de ce travail est d'analyser et d'étudier la variation saisonnière des caractéristiques du rythme de l'activité locomotrice d'*Orchestia montagui*, Amphipode vivant en sympatrie avec sept autres espèces d'Amphipodes dans l'étage supra littoral.

Matériel et Méthodes

L'activité locomotrice d'*Orchestia montagui* a été enregistrée dans une population issue des berges de la lagune de Bizerte (Nord de la Tunisie), au mois de juin (photophase naturelle = 14h37) et au mois de décembre (photophase naturelle = 9h39). Les individus adultes, collectés manuellement ont été transférés, au laboratoire, individuellement, dans des actographes placés dans une enceinte climatique permettant de contrôler aussi bien la température que la photopériode. Les spécimens d'*Orchestia montagui*, maintenus sous une température constante de 18 ± 0.5°C, ont été soumis, durant la première semaine à la photopériode naturelle du jour de la collecte puis ont été maintenus durant la deuxième semaine, en libre cours (obscurité continue).

Résultats et discussion

L'analyse des actogrammes en double plot, ainsi que les courbes d'activité locomotrice moyenne par heure et par jour ont permis de mettre en évidence une sensibilité plus importante des individus testés vis-à-vis de l'aube expérimentale et ceci quelle que soit la saison considérée (Figure1).

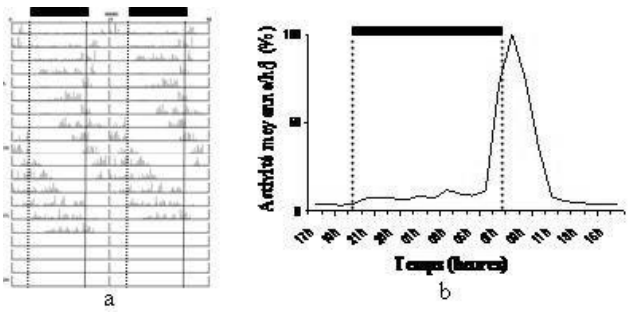


Fig. 1.

L'étude des caractéristiques du rythme de l'activité locomotrice (période circadienne sous cycle nLD ; période circadienne en libre cours; stabilité du rythme [SNR] ; pourcentage de rythmicité, rapport temps d'activité/temps de repos) a montré que quelle que soit la saison, été ou hiver, le taux de rythmicité circadienne d'*Orchestia montagui* est beaucoup plus important en présence de synchroniseur (alternance lumière / obscurité) qu'en obscurité continue (DD). De même, ce taux de rythmicité est plus important durant la saison estivale qu'hivernale. Cette rythmicité, bien marquée en été, permet aux animaux d'éviter la déshydratation pendant les heures où la température est élevée. D'autre part, l'analyse statistique montre que le rythme locomoteur d'*Orchestia montagui* est statistiquement plus stable en été qu'en hiver et ceci en présence de synchroniseur. Enfin, quel que soit le régime photopériodique imposé (LD ou DD), les animaux sont plus actifs en été qu'en hiver (Tableau1).

Tab. 1.

		Eté	Hiver	Test Wilcoxon	Test χ^2
Rythmicité circadienne (%)	LD	93.33 (28/30)	73.3 (22/30)		S (p = 0.03)
	DD	63.33 (19/30)	60 (18/30)		NS
Période Circadienne (τ)	LD	24h15±0h54	23h59±1h01	NS	
	DD	25h53±0h53	25h51±1h13	NS	
SNR	LD	0.562±0.349	0.17±0.13	HS (p = 0.001)	
	DD	0.395±0.34	0.185± 0.199	NS	
Temps d'activité	LD	11h12±5h31	9h11±4h38	NS	
	DD	10h06±6h46	8h59±4h42	HS (p = 0.002)	

References

1 - Bregazzi P. K. & Naylor E., 1972. The locomotor activity rhythm of *Talitrus saltator* (Montagu) (Crustacea, Amphipoda). *J. Exp. Biol*., 57: 375-391.

2 - Williams J. A., 1980. Environmental Influence on the locomotor activity rhythm of *Talitrus saltator* (Crustacea, Amphipoda). *Marine Biology*, 57: 7-16.

3 - Williams J. A., 1982. Environmental Influence on the locomotor activity rhythm of the sand shore Amphipod, *Talorchestia deshayesii*. *Marine Biology* (69): 69-71.

APPORT DU PROJET D'AMÉNAGEMENT DE LA VALLÉE DU BOU REGREG SUR LA QUALITÉ ENVIRONNEMENTALE DE L'ESTUAIRE

Abderrahman Nounah [1]*, Essediya Cherkaoui [2] and Fatima Benradi [2]
[1] Laboratoire nucléaire, département de chimie, Faculté des Sciences de Raba, 1014 Rabat Maroc
[2] Laboratoire : Energétique, Matériaux et Environnement, Ecole Supérieure de Technologie de Salé, Salé-Médina 11000 Maroc - abnounah@yahoo.fr

Abstract
L'estuaire de Bou Regreg a été progressivement délaissé, n'offrant que quelques rares activités de loisirs. Le développement des deux villes riveraines, Rabat et Salé, s'est accompagné d'une multiplication et d'une intensification des impacts anthropiques, surtout après l'installation du barrage Sidi Mohammed Ben Abdellah en 1974 à 23 km de son embouchure. Cette étude compare l'état environnemental de la vallée du Bou Regreg avant les travaux d'aménagement et trois ans après.
Keywords: Coastal Management, Sewage Pollution

Introduction
Le projet de dépollution de l'estuaire et du littoral, considéré comme prioritaire, entre dans le cadre du projet d'aménagement de la vallée du Bou Regreg [1]. Cette vallée constitue un élément d'union entre les deux villes historiques et s'étale sur une superficie de 6 000 ha, allant de l'embouchure de Bou Regreg jusqu'au barrage Sidi Mohammed Ben Abdellah.

Projet de dépollution de l'estuaire et du littoral
Ce projet a accordé un intérêt particulier à l'environnement et à la préservation de l'écosystème [2]. La dépollution de la vallée et du fleuve, la réhabilitation et le reboisement des carrières, la sauvegarde du site naturel dans son ensemble étaient les premières démarches entamées. Ainsi, plusieurs actions visant la généralisation de la haute qualité environnementale ont été progressivement entreprises notamment dans les domaines suivants :
- **Assainissement solide**, avec l'ouverture de la décharge d'Oum Azza en remplacement de la décharge de l'Oulja réhabilitée et définitivement fermée en 2006 et de celle d'Akreuch, en cours de réhabilitation, permettant ainsi de mettre fin à toute forme de pollution qu'elles engendraient y compris les rejets de lixiviats dans l'estuaire.
- **Assainissement liquide**, qui consiste en l'installation d'un réseau d'assainissement liquide couvrant toute la région de la wilaya de Rabat - Salé. Il doit conduire, à terme, les effluents vers deux stations de prétraitement à Rabat (station de Youssoufia bas) et à Salé. Durant ces trois années de travaux, en plus de l'élimination de plusieurs rejets des eaux usées localisés le long de l'estuaire (Figure 1) - surtout dans la partie aval du pont My El Hassan qui correspond à la première séquence de ce projet - il y a eu : - réhabilitation du site par la fermeture de la décharge d'Oulja, - transformation de la décharge d'Akreuch en centre de transfert, - réhabilitation des carrières et reboisement des collines, - construction du nouveau pont My Hassan, - creusement d'un tunnel sous la colline des Oudayas, - réalisation du projet de tramway de Rabat Salé.

Etat de l'estuaire avant et après le lancement des travaux d'aménagement :
Avant le commencement du projet d'aménagement de la vallée du Bou Regreg et en absence d'un système de dépollution, l'estuaire du Bou Regreg et le littoral recevaient une pollution essentiellement organique estimée à 200 000 m³/j d'eaux usées. En comparant avec les normes des eaux de baignade marocaines du point de vue qualité, les eaux de l'estuaire sont très polluées et généralement impropres à la baignade [3], [4]. Dans la partie située en aval du pont My El Hassan, les eaux de l'estuaire restent très polluées avec des fortes concentrations de coliformes fécaux (CF) bien qu'ils aient subit une diminution de 4 $x10^6$ CF/100ml en 1999 [4] à 2,1 $x10^6$ CF/100ml en 2008. Leurs concentrations restent toujours supérieures à celles des streptocoques fécaux (SF). Le rapport CF/SF est supérieur à 4 ce qui nous permet de conclure que la pollution est d'origine fécale humaine.

Conclusion
Après trois ans de travaux d'aménagement, seule la partie située en aval du pont Moulay El Hassan a connu une dépollution presque totale, mais le problème persiste toujours parce que cette partie subit l'influence des eaux polluées de l'oued à basse mer et des eaux du littoral à haute mer.

References
1 - Anonyme., 2007. Etude d'impact sur l'environnement du projet d'aménagement du Bou Regreg rapport CID 2007.
2 - WWW. BouRegreg. Com
3 - Cherkaoui E., A. Bayed, C. Hily., 2003. Organisation spatiale des peuplements macrozoobenthiques subtidaux d'un estuaire de la côte atlantique marocaine : l'estuaire du Bou Regreg. *Cah. Bio. Mar*. 22 : 339-352.

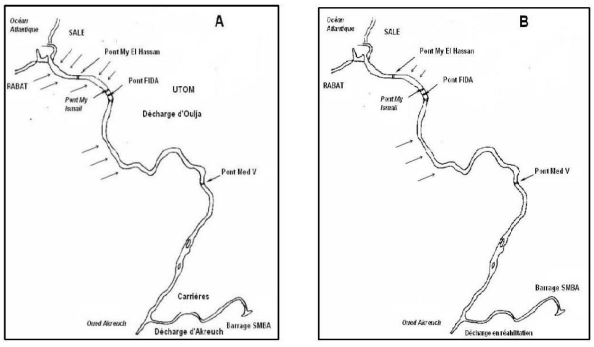


Fig. 1. Localisation des sources de pollution de l'estuaire du Bou Regreg avant le plan de dépollution (A) et après trois ans des travaux d'aménagement (B)

RISK OF INUNDATION CAUSED BY SEA LEVEL RISE ALONG THE BULGARIAN BLACK SEA COAST

Atanas Palazov [1]* and Hristo Stanchev [1]
[1] Institute of Oceanology, Bulgarian Academy of Sciences - palazov@io-bas.bg

Abstract
Over recent decades the increased frequency of natural hazards resulting from global climate change has become one of the most severe problems affecting the sustainability of the coastal zone. In particular, low-lying areas which are strongly affected by flooding pose the most serious consequences for the functions of coastal systems and public safety. Such areas are also most attractive and productive environments both for settlements and human activities because they offer great variety of possibilities for better livelihoods, easy access to the sea, and wide and vast beaches. These settings make even more important the efforts to identify coastal areas with high priority of risks to sea flooding.
Keywords: Black Sea, Coastal Processes, Sea Level

Introduction
The Bulgarian Black Sea coast has a length of 412 km, as 58% of it is exposed to progressive coastal erosion and landslide processes [1,2]. Such natural hazards have been aggravated by increasing anthropogenic impacts associated with accelerated urbanisation and human influence along the coast. There are 14 Bulgarian Black Sea coastal municipalities which embrace about 5.21 % from the entire territory of the country and hosted about 8.85 % of the national population. Coastal units potentially vulnerable to sea level rise along the Bulgarian coast are firths, lagoons, sandy beaches and dunes often being also under subsidence processes. Firths and lagoons are typical of the Bulgarian coastal zone. Firth configuration almost repeats the contours of old river valleys drowned during the Holocene. The number of firths and lagoons are 26 and 5 respectively [3]. Long-term sea level changes along the Bulgarian Black Sea coast have been traced for more than 100-year period. Based on the records of two sea level gauges, located at towns of Varna and Burgas, a continuous sea level increase has been found, particularly over the last few decades. Natural and anthropogenic factors are pointed out as the main causes for accelerated sea-level rise. The natural factors involved include changing river discharge into the Black Sea, rainfall-evaporation balance and water exchange through the straights linking the Black Sea to the Mediterranean [3]. The mean values of average sea level rise for the Western part of the Black Sea vary between 1.5 mm/y and 3 mm/y [4]. Although such rates are not dramatic for the Bulgarian coast there would be a case of sudden sea level rise under certain meteorological conditions. In contrast to climate change-induced sea level rise, which can be predicted over a middle-time scale, the extreme sea level increase associated with storm surges, tsunamis and rain-storms could have a short, but particular devastating impact on coastal areas. Significant coastal changes typically occur during such extreme events. As a consequence, functions and values of the coastal systems could be degraded, and public safety and economy could be affected [5]. Coastal storms are extreme meteorological events that mainly occur along the Bulgarian Black Sea coast in winter with the strongest N and NE winds. There are some examples of extreme events along the Bulgarian coast: the storm happened in February 1979 accompanied by sea level increase; and the storm in June 2006, also combined with pour rains. Extreme wind waves are the main cause of flooding in low-lying coastal territories.

Analysis
To indicate low-laying territories potentially vulnerable to flooding due to extreme sea level rise along the Bulgarian coast, medium scale 1:50 000 topographic maps were used [6]. Maps processing includes a series of steps: scanning, geo-referencing and digitizing with help of Geographic Information System (GIS) ArcInfo 9.2. The following approach was accepted: sea level rise scenarios from 1 to 5 m with interval of 1 m were assumed on the basis of historical background and data collected over a 100-year period (Fig. 1). The performed analysis shows that 14 towns, 17 villages, 13 sea resorts and 7 small campsites would be potentially flooded by extreme sea level rise of 5 m. Number of affected coastal population counts almost 100 000 from all 549 765 residents at these sites, according to last Census data [7]. Low-laying areas around Varna Bay, Kamchia River resort, Burgas town, Sunny beach resort, Pomorie town and coastal section between Albena resort and Kranevo village were identified as most vulnerable to inundation (Table 1). The risk to flooding is higher in summer presumably due to greater numbers of tourists having their rest at the sea coast. In summary, about 20% (83 km) of the entire 412 km long Bulgarian coast are indicated as flood-prone territories or these are coastal units most vulnerable to inundation due to extreme sea level rise of 5 m. Total number of local coastal residents at these sites constitutes 6.93% of country's population.

Conclusions
Sea level rise along the Bulgarian Black Sea coast up to 1 m could cause damages on 7% of the territory and population of the coastal settlements. Sea level rise up to 5 m could cause damages on 21% of the territory and 16% of the population of the coastal settlements. Expected damages in residential area caused by inundation of 1 m would amount to 33% of territory and 42% of population from those affected by inundation of 5 m. As the most risks zones are defined the territories around of the towns of Varna, Burgas, Balchik, Pomorie and Nessebar, Kamchia river region, Sunny beach and Albena resorts. Totally, between 40 and 97 thousand local residence could be affected and between 9 and 27 square km of settlements inundated in case of different scenarios. Although the probability of casualties due to extreme storms is quite high, in actual fact the economic losses in terms of hotel, transport and other infrastructure damages are predominant. As a result of such events the economy of a small municipality like Nessebar will be greatly affected due to its high dependence on the tourist industry. Therefore, many potential users and institutions interested in sustainable development, including local government, civil protection authorities, stakeholders, coastal decision makers and community would benefit from the results obtained for coastal hazards to elaborate appropriate mitigation measures and adaptation policies.

References
1 - Stanchev, H., 2009. Studying Coastline Length through GIS Techniques Approach: a Case of the Bulgarian Coast. Compt. Rend. *Acad. Bulg. Sci*. (under press).
2 - Peychev, V. Stancheva M., 2009. Changes of Sediment Balance at the Bulgarian Black Sea Coastal Zone Influenced by Anthropogenic Impacts. Compt. Rend. *Acad. Bulg. Sci*., Tome 62, ? 2, 277-285.
3 - Dachev, V., 2000. Implications of accelerated sea-level rise (ASLR) for Bulgaria. Proceedings of SURVAS Expert Workshop on European Vulnerability and adaptation to impacts of Accelerated Sea-Level Rise (ASLR). Hamburg, Germany, 19 -21 June 2000, 25-28.
4 - Pashova, L. and Jovev, I., 2007. Geoid modelling for the Black Sea and future prospects. In: Guedes Soares & Kolev (eds.), Maritime Industry, Ocean Engineering and Coastal Resources. Taylor & Francis Group, London, pp. 761-768.
5 - Szlafsztein C. F., 2005. Climate change, sea-level rise and coastal natural hazards: A GIS-based vulnerability assessment, State of Para, Brazil. International Workshop on Climate Change and Human Security, 21–23 June 2005, Oslo. 1-31.
6 - Palazov, A. Stanchev, H., 2007. Coastal population hazards due to extreme sea level rise along the Bulgarian Black Sea coast. Proc. of 2nd National Scientific and Practical Conference on the Management of Hazard Situations and Population Prevention. Bulgarian Academy of Sciences, November 9, 2007, Sofia, 273-282. (In Bulgarian).
7 - Palazov A., H. Stanchev, N. Valchev., 2008. Storm surges caused sea level rise and assessment of the risk of inundation along the Bulgarian Black sea coast, Proceedings of the First JCOMM Scientific and Technical Symposium on Storm Surges, Seoul, 2-6 October 2007, WMO/TD-No. 1442, JCOMM Technical Report No. 44.

TROPHIC STATE AND NUTRIENT RATIOS IN A HELLENIC COASTAL MARINE ECOSYSTEM AFFECTED BY AGRICULTURAL ACTIVITIES

Alexandra Pavlidou [1]* And Roza Psyllidou-Giouranovits [1]
[1] HELLENIC CENTER FOR MARINE RESEARCH (HCMR) - Aleka@Ath.Hcmr.Gr

Abstract
Nutrient concentrations and their ratios in the north Lakonikos Gulf, a coastal marine environment affected mainly by agricultural activities, were used in order to describe the ecosystem and to characterize it as an oligotrophic area. The agricultural activity in the adjacent plain, the Evrotas River discharges as well as the small streams inputs in the area seems to have insignificant impact in the marine environment. Nitrogen limitation was observed in the study area.
Keywords: Coastal Systems, Nutrients

INTRODUCTION
Measuring nutrient concentrations is a topical concern in many coastal systems, since the anthropogenic nutrient enrichment may result in a change of the trophic state of an ecosystem [1]. Excess nutrients (N and P) discharged from anthropogenic activities have been identified as one of the major pollution point sources leading to eutrophication in the coastal waters.
The coastal area of Lakonikos Gulf (36°44.06' N and 22°34.96' E) (Fig. 1) is mainly used for agricultural purposes, with a few small towns and tourist sites located along the coastline. Fishing activity is also developed in the area. The industrial activities in Lakonikos Gulf are very few, thus in terms of pollution sources, the aforementioned agricultural activities and untreated domestic effluents are the most important. Nutrient samples were collected from a grid of 29 sampling stations in the northern sector of the Lakonikos Gulf during June 2008, in order to present the nutrient concentrations and their ratios in Lakonikos gulf and to determine the trophic state in the area.

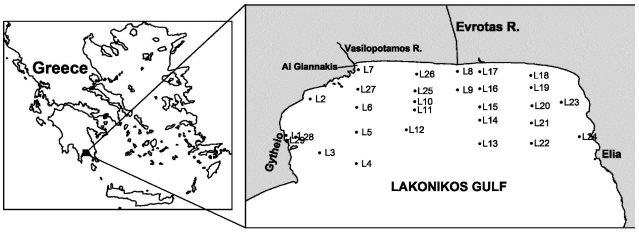


Fig. 1. Study area location and sampling stations grid

RESULTS AND DISCUSSION
Low nutrient concentrations were measured in the study area (0.100 μM for phosphate; 0.207 μM for nitrate; 1.274 μM for silicate; 0.051 for nitrite; 0.258 for ammonium). To determine the trophic state in the area, a concentration scale proposed by Karydis [2] was used, dividing the area into 4 different trophic levels: oligotrophic (<0.07 μM, phosphate; <0.62 μM, nitrate; <0.55 μM, ammonium), lower mesotrophic (0.07-0.14 μM, phosphate; 0.62-0.65 μM, nitrate; 0.55-1.05 μM, ammonium), upper mesotrophic (0.14-0.68 μM, phosphate; 0.65-1.19 μM, nitrate; 1.05-2.20 μM, ammonium) and eutrophic (>0.68 μM, phosphate; >1.19 μM, nitrate; >2.20 μM, ammonium). Inorganic phosphorus at stations L04, L05, L07 and L17 corresponded to an oligotrophic state according to the Karydis concentration scale, whereas at all the other stations inorganic phosphorus corresponded to a lower mesotrophic state. The nitrate concentrations measured in the study area showed higher mesotrophic waters only for the deeper layers of stations L12 and L13 and oligotrophic for all the other sampling stations. In general, higher nitrate concentrations were observed in deeper water layers. Ammonium concentrations showed lower mesotrophic water type for station L23 and oligotrophic water type for all the other stations. The mean N:P ratio ranged between 1.49 and 11.8 with a mean N:P ratio of 5.27. The mean Si:P ratio calculated 12.7 and the mean Si:N ratio calculated 3.26. It is noteworthy, that the N:P ratio is significantly declined due to very low nitrate concentrations at the upper layer of the water column. According to Justic et al. [3], three criteria have been applied for P-limitation, N-limitation and Si-limitation as follows: a) P-limitation, if Si:P>22 and N:P>22; b) N-limitation, if N:P<10 and Si:N>1; c) Si limitation, if Si:P<10 and Si:N<10. 83% of our data indicated N-limitation whereas, 27% indicated Si-limitation. P-limitation was not found. According to these results, nitrogen controls the functioning of Lakonikos marine ecosystem. In general, the study area was characterized as an oligotrophic area indicating that the agricultural activity in the adjacent plain, the Evrotas River discharges as well as the small streams inputs in the area seems to have insignificant impact in the marine environment.

References
1 - D'Elia, C.F., Sanders, J.G. and Boynton, W.R. 1986. Nutrient enrichment studies in a coastal plain estuary: phytoplankton growth in large-scale, continuous cultures. *Can. J. Fish. Aquat. Sci*. 43: 397-406.
2 - Karydis, M. 1999. Evaluation of the trophic levels in greek coastal ecosystems. *In*: Karydis (ed) Scientific Report, Univ. of Aegean, Lesvos Island.
3 - Justic, D., Rabalais, N., Turner, R. and Dortch, Q. 1995. Changes in Nutrient structure of River-dominated Coastal –Waters: Stoichiometric Nutrient Balance and its Consequences. *Estuarine, Coastal and Shelf Science* 40: 339-356.

SESAME PROGRAM : RECENT EVOLUTION OF PHYTOPLANKTON COMMUNITIES IN NORTH-WESTERN MEDITERRANEAN COASTAL WATERS

Bernard Queguiner [1]*, Mathias Girault [1] and Beatriz Beker [2]
[1] Laboratoire d'Oceanographie Physique et Chimique / Centre d'Oceanologie de Marseille, 13288, France - bernard.queguiner@univmed.fr
[2] Service d'observation, Centre d'Oceanologie de Marseille, 13288, France

Abstract
Results obtained during the SESAME program emphasize major changes in phytoplankton communities. The nutrient limitation is characterized by an increased duration of limitation by phosphate which has gradually extended from January to all the first 6 months of the year between 1996 and 2007. Taxonomic data collected since 1994 shows a high variability of phytoplankton developments. Bloom seasonality is slightly marked although it tends to occur during winter and spring when the environment is replenished with nutrients. A long-term of biodiversity loss is observed as well as a disruption marked by decreasing cell concentrations around 1996-1997. The evolution of a few phytoplankton species of diatoms and dinoflagellates indicates another change around 1998-1999. Results are interpreted with reference to the North Atlantic Oscillation.
Keywords: Phytoplankton, Biodiversity, Coastal Systems, Nutrients, Gulf Of Lions

We have analyzed datafrom the CNRS-INSU SOMLIT observation program at three stations of the French Mediterranean coast, from Banyuls/mer to Villefanche/mer. The 3 stations show different trends. With regard to nutrient limitation, the time-series of Banyuls/mer and Marseille both show a gradual change that results in an increased period of limitation by phosphate which has gradually extended from January to the first 6 months of the year between 1996 and 2007. The situation appears more stable in the bay of Villefranche/mer. This contrast partly reflects changes in river flows during the last decade in the Gulf of Lions. Recently, Ludwig *et al.* (2009) documented a drastic increase of the NO_3/PO_4 ratio of Rhône River freshwater from ~20 to ~80 in between 1990 and 2000. This trend is a general feature of the Mediterranean Sea and appears related to mitigation strategies for urban pollution treatment targeting the reduction of phosphorus emissions. Ludwig *et al.* (2009) also highlight the increase of potential limitation of marine primary production by both phosphate and silicic acid, the latter being more a problem for coastal phytoplankton community changes (shift from diatoms to flagellates). An examination of taxonomic data collected since 1994 on a fortnightly basis shows a high variability of phytoplankton developments in coastal waters. Seasonality of blooms is only slightly marked although they tend to occur during winter and spring when the environment is replenished with nutrients after strong wind (mistral) events. The data set shows a disruption marked by decreasing cell concentrations of microphytoplankton around the years 1996-1997.

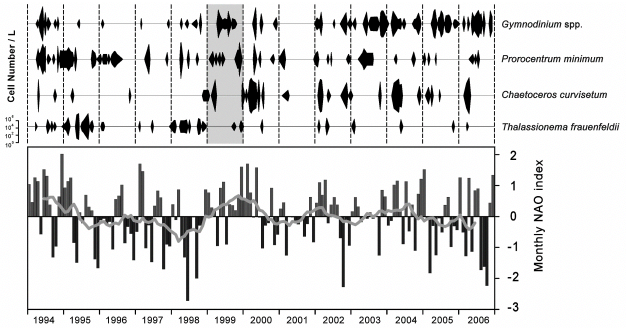


Fig. 1. Evolution of 4 sentinel species of the Bay of Marseille in parallel to that of the monthly NAO (North Atlantic Oscillation) index (the green curve represents 12 months central moving average of the monthly NAO index).

Of the 228 taxa of diatoms and of dinoflagellates that were observed in the Bay of Marseille, only a few show an interesting development that is manifested by their appearance or disappearance from the ecosystem. The dinoflagellate *Prorocentrum minimum* decreased sharply after 1999, while the genus *Gymnodinium* seemed to find more favourable conditions for its development. For diatoms, from the same period, *Chaetoceros curvisetum* became very common while *Thalassionema frauenfeldii* almost disappeared in the records. These species can be considered sentinel species whose presence or absence is a reflection of changes in environmental conditions. It is interesting to note that the period shift corresponds well to a persisting maximum in the monthly NAO (North Atlantic OScillation) index temporal evolution.

Changes in diversity showed a surprising contrast with changes in the NAO index. The period 1999-2000, characterized by a positive NAO index, corresponds to a large decrease in the Shannon index and the Pielou evenness concomitant with evolution of the sentinel species mentioned above. The decrease of diversity also matched the seasonal extension of potentially limiting conditions for phosphate although available nutrient data do not offer a sufficient background to describe accurately the evolution of the nutritional environment of phytoplankton for the period prior to 1996. It is therefore possible that anthropogenic changes have directly influenced the microphytoplankton community structure, including the dissolved Si/P ratio known to control the seasonal succession. However, the system does not appear to have suffered from severe disturbance, as no proliferation of flagellates has so far been observed over the study period. A second sharp decrease of diversity was observed in 2004, particularly marked for the H index, and occurring in parallel with an increase in phytoplankton bloom intensity (in terms of biomass) in the Bay of Marseille. The accumulation of phytoplankton biomass reflects the imbalance between the production processes and the consumption processes including grazing by zooplankton and the shift in phytoplankton species and biodiversity could be linked to changes in the community of grazers (Katechakis *et al.*, 2002). It is therefore possible that the trend observed at the end of the series is a reflection of profound changes in the pelagic ecosystem.

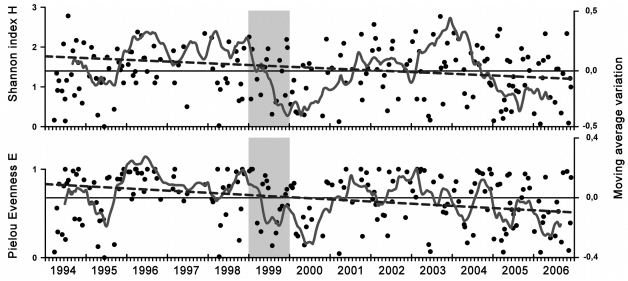


Fig. 2. Long-term evolution of the Shannon (1948) index (H) and of the Pielou (1966) evenness (E) of microphytoplankton in the Bay of Marseille. The grey curves show the variations of the 6 months central moving average of daily interpolated data normalized against the average of each data set. The dotted lines represent the trends of declining diversity for the 1994–2006 period.

References
1 - Katechakis A., Stibor H., Sommer U., Hansen T., 2002. Changes in the phytoplankton community and microbial food web of Blanes Bay (Catalan Sea, NW Mediterranean) under prolonged grazing pressure by doliolids (Tunicata), cladocerans or copepods (Crustacea). *Marine Ecology Progress Series*, 234:55-69.

2 - Ludwig W., Dumont E., Meybeck M., Heussner S., 2009. River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers for ecosystem changes during past and future decades? *Progress In Oceanography*, 80:199-217.

THE SPECIMED PROJECT : STRUCTURES OF PLANKTONIC ECOSYSTEMS IN THE NORTH-WESTERN MEDITERRANEAN

Bernard Queguiner [1]*
[1] Laboratoire d'Oceanographie Physique et Chimique / Centre d'Oceanologie de Marseille, 13288, France - bernard.queguiner@univmed.fr

Abstract
As a step towards operational management of marine ecosystems SPECiMed will develop a predictive understanding of how marine biogeochemical cycles and ecosystems respond to changing forcings, including how large-scale climatic variations impact regional ecosystem functioning through the changing physical dynamics and the alteration of biogeochemical cycles. SPECiMed relies on the joint expertise of oceanographers from the fields of physics, chemistry and biology to comprehend the ecosystem response to forcing. The 3-yearproject relies on the existing SOMLIT coastal stations of Marseille (SOFCOM) and Banyuls/mer (SOLA) and will implement the two shelf stations JULIO (SE entrance of the GoL) and MOLA (SW exit).
Keywords: Phytoplankton, Zooplankton , Nutrients, Mesoscale Phenomena, Monitoring

SPECiMed was designed as a component of the INSU-CNRS "Chantier Méditerranée" under the framework of the MERMEX project in its medium-term strategy of Enhanced Observing Periods (EOPs). In comparison with Long Observation Periods (LOPs) implemented in the framework of MOOSE (Mediterranean Ocean Observation multi-Sites on Environment), SPECiMed positions itself as an EOP designed to meet its specific scientific goals. Within MERMEX, SPECiMed will be more focused on the studies of ecological processes (biogeochemistry and food-web interactions).

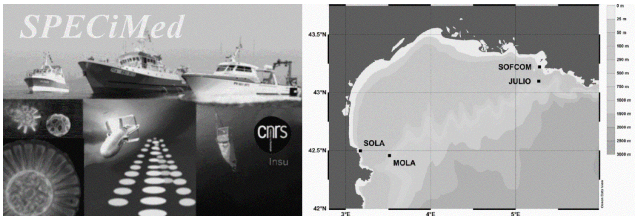


Fig. 1. SPECiMed will combine the classical methodologies and the new investigation tools for exploring the pelagic ecosystem of the Gulf of Lions.

The rapid development of the Mediterranean basin had significant positive impacts on living standards of people but it was largely achieved at the expense of environmental balances essential to human well-being. With increasing anthropogenic pressure, the Mediterranean basin has now become an endangered environment both in terms of its ecological balance and exploitable resources and of the water systems that sustain human activities. Regarding the marine environment, despite the intensive research efforts undertaken in the Mediterranean Sea for over a century, an integrated vision of how its ecosystems function is still lacking. Yet this knowledge is indispensable to meet the expectations of the Mediterranean basin development and sustainable management issues it raises.

In the northwestern Mediterranean (NWM), studies on the impact of climate on plankton communities are limited by the small number of long-term series. Nevertheless, few studies have addressed the question of the long-term drift in composition and dynamics of plankton. A long-term evolution of phytoplankton communities has been at least detected in several places of the French NWM coast, e.g. at DYFAMED station and especially in the Gulf of Lions (GoL), during the research projects EC2CO/GolPhyZ and the ongoing EU/SESAME partly devoted to plankton series data mining. The decadal variability of coastal phytoplankton in the Bay of Marseille from 1994 to 2006 suggests a close link to the North Atlantic Oscillation (via processes that still need to be assessed at the mechanistic level), a possible regime shift in the years around 1999, as well as signs of biodiversity loss.

The Mediterranean Sea is often compared to the world ocean given its thermohaline anti-estuarine circulation. It is also characterized by an eastward gradient of oligotrophy associated with a succession of different plankton communities. Therefore it is difficult to observe the evolution of the Mediterranean as a whole. Even if trends can be predicted using numerical models, these must be validated continuously in view of ongoing climate change. Therefore, the regional level appears appropriate. At first glance, the NWM basin is a mosaic of nested ecosystems offering similarities with the general situation of the World Ocean: An estuary at the mouth of a great river, the Rhône River, which brings locally large nutrient loads on a continental shelf, the GoL, and a coastal current, the Northern Current (NC), which separates the land-to-ocean aquatic continuum from an oligotrophic gyre. SPECiMed aims at establishing a three-year observation platform of plankton communities incl. bacteria, phyto-, microzoo- and mesozooplankton, associated biogeochemical cycles of major elements (C, N, P, and Si), as well as monitoring the physical environment impacting the pelagic communities.

Planktonic organisms generally are classified on the basis of size, nutritional, and physiological characteristics or phylogeny. Regardless of the criterion used, broad diversity is revealed, as illustrated in Figure 2. Thus, the planktonic organisms include several size-classes, from < 1 µm to several cm, so that sampling as well as quantitative observation of SPECiMED will take advantage of the use of several complementary means of investigation, each appropriate to one part of the size spectrum. SPECiMED will also develop the parallel use of *in situ* sensors like Lase Optical Plankton Counter (LOPC), Laser In Situ Scaterrometer and Transmissiometer (LISST) mounted on tracted Moving Vessel Profilers (MVP) in conjunction with hull-mounted ADCP to explore the mesoscale field of phyto- and zooplankton. While continuous measurements of currents will be performed by bottom ADCP moorings, integration between biology, geochemistry and physics will be provided by the coupled physical-biogeochemical multi-element multi-species model *Eco3M*.

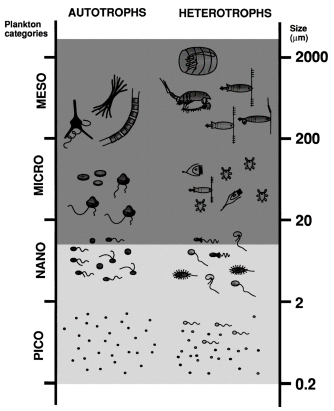


Fig. 2. Representative classification of planktonic organisms by size showing the diversity of various autotrophic and heterotrophic groups (modified from Karl, 1999). The dark area corresponds to the compartments for which historical time-series data are available in the Gulf of Lions, the light grey area corresponds to the compartments for which detailed information is lacking.

References
1 - Karl D.M., Bidigare R.R., Letelier R.M., 2001. Long-term changes in plankton community structure and productivity in the North Pacific Subtropical Gyre: The domain shift hypothesis. *Deep Sea Research* Part II: Topical Studies in Oceanography, 48:1449-1470.

CARTOGRAPHIE DE LA SENSIBILITÉ DES SOLS À L'ÉROSION, AU NIVEAU DU BASSIN VERSANT DE L'OUED LAOU (RIF NORD OCCIDENTAL, MAROC).

A. Raissouni [1]*, M. Maatouk [1], M. Wahbi [1], Y. Wahbi [2] and A. El Arrim [1]
[1] Faculté des Sciences et Techniques (FST), Univ. Abdelmalek Essaidi, Tanger, 90000 Maroc - ah_raissouni@hotmail.com
[2] Ecole Mohammadia des ingénieurs Rabat, Agdal Rabat, Maroc

Abstract
Le Maroc constitue l'une des régions du pourtour méditerranéen où l'érosion est la plus importante. Dans cette étude nous avons dressé, à partir de la cartographie des paramètres et facteurs de l'érosion (lithologie, géomorphologie, relief, occupation du sol), une carte de sensibilité à l'érosion dans le bassin versant de l'oued Laou. Le résultat montre une forte érodabilité des terres dans les secteurs Sud-est et Nord-ouest du bassin qui sont des terrains à fortes pentes.
Keywords: Erosion, Sediment Transport

Le Maroc constitue l'une des régions du pourtour méditerranéen où l'érosion est la plus importante. Ce fléau touche plus particulièrement la région du Rif constitué essentiellement de formations friables, où les précipitations sont de type torrentielles et dont la couverture végétale a connu une forte dégradation ces dernières décennies. Dans cette étude, nous nous sommes intéressés au bassin versant de l'oued Laou qui se situe dans des provinces de Tétouan et de Chefchaouen entre 35°29'22" N et 35°00'54" N, et 05°04'16" W et 05° 26'05" (NW du Maroc). Il couvre une superficie de 939,242 Km² et un périmètre de 168,335 km. L'objectif de ce travail est d'évaluer la sensibilité des sols au niveau du bassin versant de l'oued Laou. La méthodologie consiste à cartographier les paramètres les plus significatifs intervenant directement dans l'érosion : la topographie, la lithologie, la géomorphologie et l'occupation du sol. Une base de données a été constituée pour chaque facteur et intégrée dans un système d'information géographique.

Paramètres d'évaluation

Lithologie : La lithologie du bassin étudié présente une forte résistance au niveau de la dorsale calcaire et les dépôts paléozoïques et une très forte érodabilité pour les dépôts du Quaternaire et les alluvions. *Relief :* À l'exception de la plaine côtière, la zone étudiée montre un relief accidenté avec des pentes abruptes. L'utilisation du Modèle Numérique de Terrain (MNT) au pas de 10 m, généré à partir de la numérisation des courbes de niveau, nous a permis d'extraire la carte des classes de pentes. *Occupation du sol :* le couvert végétal du bassin de l'oued Laou induit une forte érodabilité au niveau des terrains non boisés et une diminution au niveau des forêts de feuillus qui sont plus résistants à l'érosion. *Géomorphologie* **:** présence de zones de glissements de terrain et d'éboulis surtout dans les bords de l'oued, du barrage, et dans les zones à fortes pentes.

Superposition cartographique

La couche d'information est d'abord rastérisée selon la maille de base du MNT pour homogénéiser les échelles des sources de données et pouvoir ainsi les croiser spatialement. La superposition numérique des différents paramètres de l'érosion nous a permis de dresser une carte d'érosion potentielle au niveau du bassin versant de l'oued Laou. La carte obtenue (figure 1) est une information qualitative de 5 classes (très faible, faible, moyenne, élevée et très élevée), qui renseigne sur le degré de sensibilité des sols à être mobilisé par les facteurs de l'érosion hydrique [1]. La carte montre une forte érosion dans les secteurs Sud-est et Nord-ouest du bassin qui sont des zones à relief très accidenté et à pente élevée, expliquant leur grande sensibilité à l'érosion malgré des terrains des plus résistants. Cela peut également être expliqué par l'exposition de ces versants aux précipitations, aux vents dominants et à une plus longue durée de l'ensoleillement. Dans les autres zones du bassin, malgré une couverture végétale peu importante et des terrains peu résistants, la sensibilité à l'érosion reste de faible à moyenne. Ceci montre que la pente constitue, en plus du facteur climatique, est le facteur principal de l'érosion dans cette région.

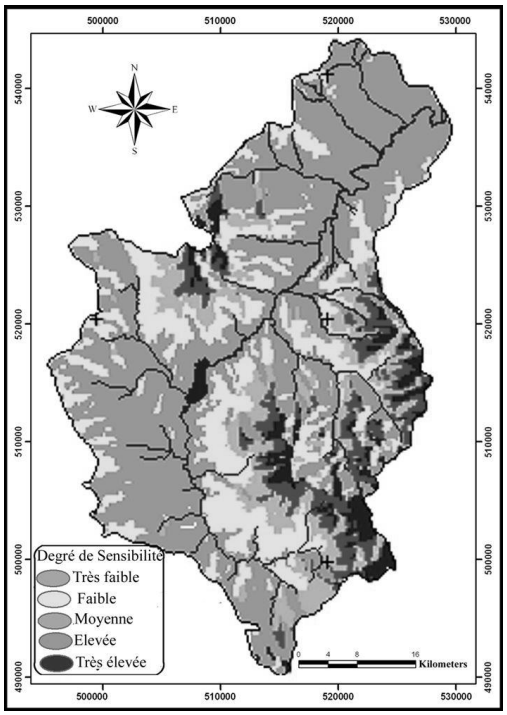


Fig. 1. Carte de sensibilité

CONCLUSION

L'approche multisource, combinant le relief, la lithologie, la géomorphologie et l'occupation du sol dans un SIG nous a permis d'identifier et de cartographier les surfaces de terres arables nécessitant la plus grande priorité d'interventions pour la protection du patrimoine sol et pour réduire les apports solides au niveau des retenues des barrages.

References

1 - RAISSOUNI A., WAHBY Y., MAATOUK M. , WAHBI M. et ELARRIM A., 2008 - Cartographie de l'érosion au niveau du bassin versant de l'oued Laou (Rif nord occidental, Maroc). Application des SIG. *20ème Colloque sur "les bassins sédimentaires marocains*", Fac. Sci., Univ. Mohammed Ier, Oujda, Maroc. pp. 53-58

EVALUATION OF BIOMARKERS RESPONSE AT THE SE GULF OF TRIESTE (SLOVENIA) AND BOKA KOTORSKA (MONTENEGRO)

Andreja Ramšak [1]*, Bojana Tkalcic [2] and Zoran Kljajic [3]
[1] Marine biology station, National institute of biology - ramsak@mbss.org
[2] 2Predstruge 66, 1312 Videm-Dobrepolje, Slovenia
[3] 3Institut za biologiju mora, Dobrota bb., p.fah 69, 85330 Kotor, Montenegro

Abstract
In order to assess spatial distribution and temporal trends of pollution, response of different biomarkers of exposure were measured at three stations in Slovenian coastal waters included in long term biomonitoring MED POL programme and at two stations in Montenegro. Biomarkers response showed no differences between stations with different ecological status. Keywords: biomonitoring, Adriatic Sea, *Mytillus galloprovincialis*
Keywords: Adriatic Sea, Mollusca, Monitoring

Introduction
A suite of biomarkers were used to measure effects of pollutants at northern and southern Adriatic, two regions with different pollution loadings and ecological characteristics. Both examined areas are still under high anthropogenic pressures with emphasizing urban and industrial wastewaters, tourism and agriculture. Both examined coastal area is highly pressured by building and reconstruction, small shipyards and maritime transportation. The coastal sea is intensively exploited by fishery and aquaculture. Chemical monitoring of sediments and sea water was mostly focused to persistent aromatic hydrocarbons and heavy metals. Distribution of certain heavy metals showed most pronounced difference between areas; stations in northern Adriatic being more loaded with mercury (1) and southern stations are more loaded with lead. The stations received different pollution loadings mostly from point sources. Ecological status of sampling stations was yearly evaluated in northern stations according to guidelines WFD (2).

Results and discussion
Biomarkers responses were measured in mussels (*Mytillus galloprovincialis)* collected from their natural beds at three sites along Slovenian coast and at two sites at Boka Kotorska Bay. Reference sites were Bay of Strunjan (SLO) and Bay of Kotor (MNE). Metallothionein concentration (MT) and micronuclei frequency (MN) was analysed and evaluated according to the recommended methodology (3), acetylcholinesterase activity (AChE) was determined using Ellman colorimetric method (4) using the whole viscera in crude homogenate and acetycholin as substrate. The statistical differences among samples from different sites were tested by the analysis of variance (ANOVA Tukey-post-hock HSD test).

Table 1. Response of biomarkers from sampling sites at northern and southern Adriatic Sea.

	Slovenia			Montenegro	
Biomarker	Bay of Koper	Bay of Strunjan	Bay of Piran	Kotor	Bijela
Ecological status after WFD	Moderate	Very good	Good	/	/
Condition index	0,12	0,14	0,12	0,09	0,09
Micronuclei frequency (‰)	5±1	3±1	3±1	3±1	4±1
Metalothioneins (µg/g w.w.)	135±16	144±13	117±7	48±5	39±5
Acetylcholin esterase activity (nmol/min mg)	8,34±1	10,7±3,2	9,46±1,4	9,45±5	12,63±1,2

Differences in circulation regime and ecological characteristics between sampling stations at northern part (SE Gulf of Trieste) with stations at southern Adriatic (closed Bay of Kotor and Bay of Tivat) make comparison and analysis of biomarkers very valuable and interesting in terms of pollutants distribution and their effect to mussels. Adoption of pollutans such as heavy metals in caged mussels at northern and southern stations revealed almost equal concentrations of Hg, Pb, Ni, but twice higher amount of Cr in Bay of Koper comparing with other stations (project Mytiad 2008). Slightly higher amount of PAH were determined in mussels from Bay of Kotor during the same experiment comparing with northern reference site Bay of Strunjan. Ten times higher content of organochlorine pesticides was found in mussels from reference site in Bay of Kotor comparing with reference site at Bay of Strunjan. Frequencies of MN were followed in the period of one year at northern stations. Higher frequency was detected during the May at the same station in Bay of Koper and in caged mussels exposed in Slovenian marinas with poor circulation and higher level of pollutants. Station in Bay of Tivat (Bijela) was exposed to higher concentrations of Cu, Pb, Zn; especially Cu can act as genotoxic agents. Condition index should be used in biomonitoring to adjust the metal concentration in mussels and to eliminate the effect of trophic differences between stations. Spatial distribution was evident in condition index among stations which corresponds the trophic conditions at sampling sites. Most pronounced difference between northern and southern stations was in MT concentrations. Three times higher MT concentration was found at northern stations comparing with southern stations in wild mussels collected and analysed at the same time. The level of MT concentration at northern stations was in the same range through ten years period (5). The level of Cd in mussels is up to 1,0 mg kg^{-1} and Hg 0,3 mg kg^{-1} with trend to decreased in last years as established through monitoring programme (6). Substantial difference in heavy metals pollution among northern and southern stations was in concentration of some metals. Station Bijela (Bay of Tivat) have higher levels of some heavy metals (arsenic and lead) with low binding capacity to MT. On the other side, the concentration of total Hg was determined to be ten times higher in northern Adriatic than in other parts (1). The higher level of MT in northern stations could be a consequence of high binding affinity of Hg to MT, even though its low induction ability. The MT concentration showed decrease from northern to southern Adriatic. Results on MT concentrations obtained in mussels from eastern coast of Istria and Kvarner (Croatia) were between 50- 100 µg/g w.w. (7). Activity of AChE was measured in whole mussel tissue and was in the same range at northern and southern stations as measured in September 2009. Lower activity of AChE was found in May at stations in Bay of Strunjan and Bay of Piran.

References
1 - Horvat, M., Kotnik, J., Fajon, V., Logar, M., Zvonaric, T., Pirrone, N., 2001. *RMZ-Mater Geoenviron*, 48:241-252.
2 - Mozetic, P., et al., 2009. Porocila MBP - Morska biološka postaja, 108. Piran: Nacionalni inštitut za biologijo, pp 106.
3 - UNEP/RAMOGE, 1999. UNEP, Athens, 94p.
4 - Ellman, L.G., Courtney, K.D., Andres Jr., V., Featherstone, R.M., 1961. Biochem. Pharmacol. 7, 88–95.
5 - Ramšak, A., 2007. MAP Tech. Reports Ser., 166, Athens: UNEP/MAP, p. 147-149. Turk, V., et al., 2009. Porocila MBP - Morska biološka postaja, 109, Piran: Nacionalni inštitut za biologijo; Ljubljana, march 2009, pp. 31.
6 - Petrovic, S., Ozretic, B., Krajnovic-Ozretic and Bobinac, D., 2001. *Mar. Pollut. Bull*. 42, 1373-1378.

EFFECTS OF OCEAN ACIDIFICATION ON JUVENILE CLAMS *RUDITAPES DECUSSATUS*

P. Range [1]*, L. Chícharo [1], M. A. Chícharo [1], R. Ben-hamadou [1], D. Piló [1], D. Matias [2], S. Joaquim [2] and A. P. Oliveira [2]
[1] Centro de Ciências do Mar, Universidade do Algarve, 8005-139 Faro, Portugal - prange@ualg.pt
[2] Instituto Nacional de Recursos Biológicos (INRB-IPIMAR)

Abstract

We report the preliminary findings of a 3 month-long experiment aimed at investigating the effects of elevated pCO_2 and reduced pH on the juvenile stages of the clam *Ruditapes decussatus*. The concentration of CO2 in seawater was manipulated by diffusing pure CO_2, to attain two reduced pH treatments (-0.4 and -0.7 pH units), which were compared to seawater with natural pH levels. We found no differences among treatments in the size or weight of the clams. The natural pH treatment showed significantly larger mortality than the acidified treatments. The peak of mortality coincided with the occurrence of sporadic spawning events, which were not observed in the most extreme acidification treatment. This suggests that the increased survival under acidified conditions may be associated with a delay in the reproductive cycle of the clams.

Keywords: Carbon, Bivalves, Coastal Waters, Physiology, Ph

Introduction. Anthropogenic emissions of carbon dioxide (CO_2) are changing the carbonate chemistry of seawater, causing decreases in pH and in the saturation state of carbonate minerals, which are major components for biological calcification. Whether and how this process of "ocean acidification" will affect marine organisms is currently a topic of great concern. The detrimental effects of acidic waters on bivalves have long been identified (1) and a critical pH value (<7.0) has even been proposed in relation to marine bivalves (2). More recent studies indicate that future CO_2 concentrations, predicted by the IPCC scenarios, can significant reduce calcification (3) and growth (4,5) of bivalves. Other aspects of bivalve physiology previously shown to be affected by reduced pH include acid-base regulation (4), respiration (4) and reproductive output (6). Here we report the preliminary findings of a 3 month-long experiment aimed at investigating the effects of elevated pCO_2 and reduced pH on the juvenile stages of the clam *Ruditapes decussatus*.

Methods. The experiment started on 09/06/2009 and ended on 23/10/2009. The rearing system was open, supplied with a continuous flow of filtered natural seawater to minimize the interference from the metabolic waste-products of the organisms. Seawater chemistry was manipulated by diffusing pure CO_2, to attain two reduced pH treatments (-0.4 and -0.7 pH units), which were compared to seawater with natural pH levels. Each level of pH had 3 replicate tanks with clams, each stocked with 100 juvenile clams. Temperature and salinity were not controlled, but were continuously monitored, along with pH. Combined with measurements of total alkalinity and dissolved oxygen, taken at regular intervals, these variables allowed the estimation of the amount of carbonates in the seawater. The bivalves were fed in continuous flow with an adequate mixture of microalgae. The response of the juvenile clams was measured in terms of mortality, growth, biochemical composition, calcification and microstructure of the shell. The physiological response was also evaluated, in terms of feeding behaviour and metabolic rates.

Results and Discussion. Values of pH recorded during the experiment were maintained within the planned intervals (Mean ± SD): pH -0.7 (7.50 ± 0.12); pH -0.4 (7.81 ± 0.06); pH CT (8.14 ± 0.09). During the first 75 days the clams grew from 10.2 ± 2.29 mm to 12.4 ± 2.51 mm (shell-length, mean ± SD). We found no differences among treatments in terms of the average size or weight of the clams. After 75 days there was a significant difference in survival between the natural pH and the two acidified treatments: pH -0.4 = pH -0.7 > pH CT (Figure 1). In contrast, the RNA/DNA condition index revealed an opposite pattern: pH CT > pH -0.4 > pH -0.7.

Considering the reported effects of acidic seawater on bivalves, the decreased mortality of *R. decussatus*juveniles under reduced pH conditions was an unexpected result. Some earlier studies (1,7) did not specifically addressed increasing CO_2 concentrations and other methods of acidification were used, so their results should be interpreted with caution. The peak mortality in our experiment occurred in the same tanks where a spawning event was observed, just a few days before. No spawning was observed in the pH -0.7 treatment, which suggests the increased survival in that treatment may be associated with a delay in the reproductive development of the clams. The pattern of reduced growth under experimental conditions of reduced pH, previously reported for other species of bivalves (4,5), was also not apparent in our study. It is important to note, however, that the pH reductions imposed in our experiment, although within the range of values projected by IPCC, were not as severe as in those previous studies. Further clarification and interpretation of the preliminary findings reported here is expected when the full dataset is available.

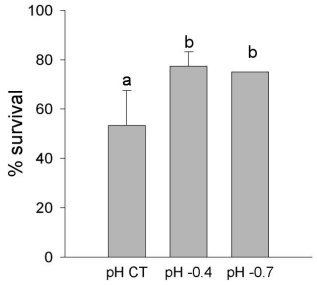


Fig. 1. Mean (+ SD; n=3) survival after 95 days for each of the 3 pH levels considered; letters identify groups of means that are significantly different (SNK tests, $p<0.05$)

Acknowledgements

We would like to thank the following people for their help at various stages of this study: Ana Amaral, Alexandra Leitão, Margarete Ramos, Maurício Teixeira and Eloise de Sá. This is a contribution of the ACIDBIV project, which is part of the CIRCLE Med projects, funded by the Regional Ministry of Innovation and Industry of the Galician Government, the Italian Ministry for Environment, Land and Sea, and the Foundation for Science and Technology of Portugal, in the framework of Circle ERA Net project (which is funded by the European Commission 6th Framework Programme).

References

1 - Loosanoff, V.L. & Tommers, F.D., 1947. Effect of Low Ph Upon Rate of Water Pumping of Oysters, Ostrea Virginica. *Anatomical Record* 99, 668-669.

2 - Bamber, R.N., 1990. The Effects of Acidic Seawater on 3 Species of Lamellibranch Mollusk. *Journal of Experimental Marine Biology and Ecology* 143, 181-191.

3 - Gazeau, F. et al., 2007. Impact of elevated CO2 on shellfish calcification. *Geophysical Research Letters* 34 (7), L07603.

4 - Michaelidis, B., Ouzounis, C., Paleras, A. & Portner, H.O., 2005. Effects of long-term moderate hypercapnia on acid-base balance and growth rate in marine mussels Mytilus galloprovincialis. *Marine ecology progress series.* 293, 109.

5 - Berge, J.A., Bjerkeng, B., Pettersen, O., Schaanning, M.T. & Oxnevad, S., 2006. Effects of increased sea water concentrations of CO2 on growth of the bivalve Mytilus edulis L. *Chemosphere* 62, 681-687.

6 - Kurihara, H., 2008. Effects of CO2-driven ocean acidification on the early developmental stages of invertebrates. *MARINE ECOLOGY-PROGRESS SERIES* 373, 275-284.

7 - Calabrese, A. & Davis, H.C., 1970. Tolerances and requirements of embryos and larvae of bivalve molluscs. *Helgoland Marine Research* 20, 553-564.

SHIPPING-INDUCED SEDIMENT RESUSPENSION IN THE VENICE LAGOON, ITALY

John Rapaglia [1]*, Luca Zaggia [2], Klaus Ricklefs [3] and Morgan Gelinas [1]
[1] Christian Albrechts University of Kiel - john.rapaglia@geographie.uni-kiel.de
[2] 2. National Research Council of Italy: Institute of Marine Science (CNR-ISMAR)
[3] 3. West Coast Research and Technology Center of Kiel University

Abstract

Sediment remobilization induced by the passing of commercial tankers and cargo vessels in the Venice Lagoon, Italy was investigated during two sampling campaigns in March and July, 2009. A suite of instruments was utilized to measure suspended sediment concentration (SSC), water depth, and water velocity on the shoals alongside the shipping canal. SSC concentrations above 500 mg L^{-1}, much higher than the background concentration of 7 mg L^{-1}, were recorded at 50 cm above the sediment surface for several minutes after the passage of large ships. A threshold based on the Froude number and the size of the ship was calculated below which large waves directly linked to large SSC events do not form, thereby preventing previously isolated contaminated sediments to be reintroduced into the marine environment.

Keywords: Estuaries, Coastal Management, Sediment Transport, Waves

Introduction/Methods

Given their geographical orientation as a natural barrier to the open seas, coastal lagoons provide prime locations for shipping ports. Although the shipping industry is beneficial to the world's economy, it is important to discuss the possible negative impacts shipping can have on local ports, such as pollution from ship ballast water, introduction of invasive species and sediment resuspension and redistribution [1]. Herein, we investigate how shallow water waves produced by ships influence suspended sediments upon extended shoals in the Venice Lagoon, Italy. The sediments in the vicinity of the shipping channel are contaminated and therefore we aim to ascertain which parameters (i.e. vessel velocity, draft, width, tidal level etc.) influence the formation of powerful waves from shipping vessels outside the channel in the Venice Lagoon, and how much resuspension these waves produce. Among the variables that determine the formation of large waves, only vessel velocity and the timing of transit in relation to tidal levels can be controlled.

As the vessel velocity increases and as the size of the vessel increases the amplitude of the wave increases and therefore the probability for the formation of a shallow-water wave increases. When the shallow water wave breaks it generates high near-bottom current velocities ($U_{max;}$ m s^{-1}) along the sediment surface leading to re-suspension events [2].

$$U_{max} = \frac{\pi H}{T * \sinh \frac{2\pi h}{\lambda}}$$

Fig. 1. Equation 1

(1) where H is the wave height (m), T the wave period (s), h the water depth (m) and λ the wavelength (m). The larger the $U_{max,}$ the greater the amount of resuspension will occur. Therefore, as expected, larger resuspension events will develop in the presence of high waves. An acoustic Doppler current profiler (ADCP) was utilized to measure SSC in the canal while two optical backscatter sensor (OBS) arrays were placed 50 m onto the shoals alongside the canal at a mean depth of 1.5 m. An S4 electromagnetic current meter with an internal OBS was also placed alongside one of the OBS arrays to measure water depth and velocity. Meanwhile a canal-normal transect of pressure sensors was spaced at 100 m intervals away from the canal to reproduce the propagation length and shape of the shallow water waves. An automated identification system (AIS) was used to collect vessel size, velocity and heading data.

Results

More than 100 ships generated waves associated with SSC change as recorded by the OBS arrays, however only 10 waves were sufficiently large and steep to cause extensive resuspension events. An extensive SSC event was considered to be one in which the change in SSC was over 300 mg L^{-1} and in which the sediment remained in suspension longer than 6 minutes. Schoellhamer relates the product of the Froude number and the size of the ship to wave height [3]. Using a modified version of the Schoellhamer relationship including the water level on the shoals, we are able to determine a critical threshold of these parameters below which the shallow water waves will not attain the height or steepness necessary to create large SSC events (Figure 1). The knowledge of this threshold can help in the management practice of the lagoon.

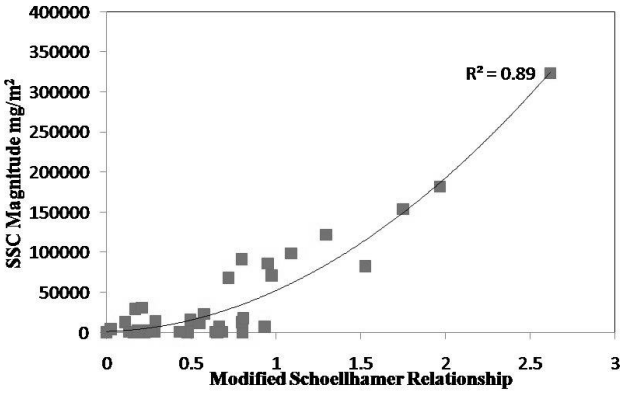


Fig. 2. SSC event magnitude versus the modified Schoellhamer parameter. Large resuspension events do not occur below the threshold of 0.75.

Pressure sensor data shows the length of wave propagation along the shoals. Though there was significant dissipation of energy with distance from the channel, large waves are still recorded at least 1000 m onto the shoal, and are likely to be the one of the primary cause of extensive subsurface erosion seen in the central lagoon over the last 30 years [4].

References

1 - Hayes K.R., and Sliwa C., 2003. Identifying potential marine pests—a deductive approach applied to Australia. *Marine Pollution Bulletin*, 46: 91-8.

2 - Hofmann H., Lorke A., Peeters F., 2008. The relative importance of wind and ship waves in the littoral zone of a large lake. *Limnology and Oceanography*, 53: 368-380.

3 - Schoellhamer D.H., 1996. Anthropogenic sediment resuspension mechanisms in a shallow microtidal estuary. *Estuarine, Coastal and Shelf Science*, 43: 533-548.

4 - Molinaroli E., Guerzoni S., Sarretta A., Masiol M., and Pistolato M., 2009. Thirty-year changes (1970 to 2000) in bathymetry and sediment texture recorded in the Lagoon of Venice sub-basins, Italy. *Marine Geology*, 258: 115-125.

SPATIAL DISTRIBUTION OF ZOOPLANKTON DURING SUMMER IN THE NORTH COAST OF SFAX (EASTERN MEDITERRANEAN SEA, TUNISIA)

A. Rekik [1], Z. Drira [1]*, W. Guermazi [1], J. Elloumi [1], S. Maalej [1] and H. Ayadi [1]

[1] Université de Sfax, Faculté des sciences de Sfax. Département des sciences de la vie. Unité de recherche UR/05ES05. Biodiversité et Ecosystèmes Aquatiques. - zaherdrira@yahoo.fr

Abstract

Copepods were the most abundant zooplankton on the North coast of Sfax, contributing to 61.29% of the total zooplankton. A total of 12 copepods families were identified in all stations, with an overwhelming abundance of Oithonidae (76.70% of copepod abundance), which were characterized by neritic r-strategy-type species dominated by *Oithona nana* (55.85% of the total copepod abundance).

Keywords: Zooplankton , Coastal Management, Copepoda

Introduction

The North Coast of Sfax is one of the main ports in the Gulf of Gabes. The coast has rich aquatic resources contributing about 65% of the national fish production in Tunisia [1]. Several findings have provided evidence that zooplankton such as copepods make a major contribution to optimal growth and fish survival. The distribution of copepod assemblages in Tunisian coastal waters has been studied in the Bay of Tunis [2], in the Tunis North Lagoon [3] and in the Gulf of Gabes [4].

Materials and methods

2.1. Sampling

Sampling was carried out in July 2007. Samples were collected from forty five stations located between 0.5 and 4.5 m along the North Coast of Sfax.

2.2. Biological parameters

Zooplankton was sampled by a cylindro-conical net. Zooplankton samples were preserved in 4% borax buffered formaldehyde solution. They were stored with pink Bengal to improve their identification and also to facilitate dissection of copepods. The enumeration was performed under a vertically mounted deep-focus dissecting microscope (Olympus TL 2).

2.3. Statistical analysis

The potential relationships between variables were tested by Pearson's correlation coefficient.

Results and discussion

Zooplankton assemblages in the North Coast of Sfax were dominated by copepods with a total of 21 species, accounting for 61.29% of the total zooplankton abundance (Fig. 1A). The spatial distribution of total zooplankton illustrates a high copepod density (61.39×10^4 individuals m^{-3}) in station 13 associated with Oithonidae aggregations. We observed great numbers of nauplii ranged between 0 and 38.86 x 10^4 individuals. m^{-3}. Copepodid stage ranged from 0 to 15.89×10^4 individuals m^{-3} and adult stage varied between 0 and 10^5 individuals m^{-3}. Cyclopoids contributed the largest fraction (76.70%) followed by harpacticoids (11.91%) calanoids (11.10%) and Poecilostomatoids (0.29%) (Fig. 1C).

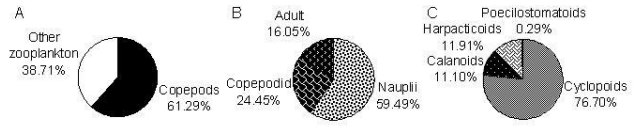


Fig. 1. Relative contribution of zooplankton abundance (A), copepods demographic class abundance (B) and copepods groups' abundance (C) in sampled stations.

A total of 12 copepod families were found in all stations, Oithonidae dominating the total abundance of copepods (76.70%), among which *Oithona nana* was the most abundant species representing 55.85% of the total copepod abundance. Species translated into a highly significant correlation between copepod and *Oithona nana* abundances ($r = 0.712$, $n = 45$, $p < 0.05$) and between total zooplankton and *Oithona nana* abundances ($r = 0.604$, $n = 45$, $p < 0.05$). The other zooplankton contributed only a small proportion of the total zooplankton (38.71%).

References

1 - CGP., 1996. Annuaire des statistiques des pêches en Tunisie. Ministère de l'Agriculture, Tunisie.

2 - Souissi S., Daly-Yahia Kefi O. and Daly-Yahia M.N., 2000. Spatial characterization of nutrient dynamics in the Bay of Tunis (southwestern Mediterranean) using multivariate analyses: consequences for phyto- and zooplankton distribution. *J. Plankton Res.*, 22: 2039-2059.

3 - Annabi-Trabelsi N., Daly-Yahia M.N., Romdhane M.S. and Ben Maïz N., 2005. Seasonal variability of planktonic copepods in Tunis North Lagoon (Tunisia, North Africa). *Cah. Biol. Mar* ., 46: 325-333.

4 - Drira Z., Belhassen M., Ayadi H., Hamza A., Zarrad R., Bouain A. and Aleya, L., 2009. Copepod community structure related to environmental factors from a summer cruise in the Gulf of Gabès (Tunisia, eastern Mediterranean Sea. *JMBA.,* doi: 10.1017/S0025315409990403: 1-13.

ASSESSMENT OF AN OPERATIONAL SYSTEM FOR FORECASTING HYPOXIC EVENTS IN THE EMILIA-ROMAGNA COASTAL AREA (NORTHERN ADRIATIC SEA)

A. Russo [1]*, A. Coluccelli [1], F. Falcieri [1], K. R. Marinaccio [1], M. Ravaioli [2], G. Bortoluzzi [2], P. Focaccia [2], G. Stanghellini [2], C. R. Ferrari [3], M. Deserti [4], J. Chiggiato [5] and I. Iermano [6]

[1] Dept. of Marine Science, Polytechnic University of Marche, Ancona, Italy - a.russo@univpm.it

[2] Institute of Marine Sciences, CNR, Bologna, Italy

[3] S.O. Daphne, ARPA Emilia-Romagna, Cesenatico, Italy

[4] Hydro-Meteo-Clima Service, ARPA Emilia Romagna, Bologna, Italy

[5] NATO Undersea Research Centre, La Spezia, Italy

[6] Stazione Zoologica "Anton Dohrn", Napoli, Italy

Abstract

Hypoxic/anoxic events affect quite frequently the northern Adriatic Sea during the warm season, especially the Po delta and the Emilia-Romagna coastal areas of south of it. Such events derive from a combination of physical, chemical and biological processes. A hydrodynamic model with a biogeochemical flux module has been producing daily 72-hour forecasts of the northern Adriatic area since June 2007. Available data have been compared to model forecasts. Computed statistics demonstrated a good model skill in forecasting hydrodynamics of the area, while skill in forecasting dissolved oxygen resulted much lower; the latter has been improved by correcting the forecast for the mean bias computed using buoy measurements of the previous 7 days.

Keywords: Adriatic Sea, Coastal Models, Anoxia, Oxygen, Coastal Waters

Anoxic and hypoxic events are observed quite frequently in the northern Adriatic Sea during the period from late spring until autumn, especially in the Po delta and the Emilia-Romagna coastal areas south of it [1]. Anoxic events are observed also in the Gulf of Trieste and, rarely, in the much wider area between the Po delta and the Istrian Peninsula. Such events negatively affect environmental conditions, fisheries, tourism of the area. In the northern Adriatic Sea, some key factors for development of hypoxic conditions are related to river runoff (influencing phytoplankton bloom, stratification of the water column, light penetration) and coastal inputs, hydrodynamics, atmospheric conditions, reactivity of the seafloor.

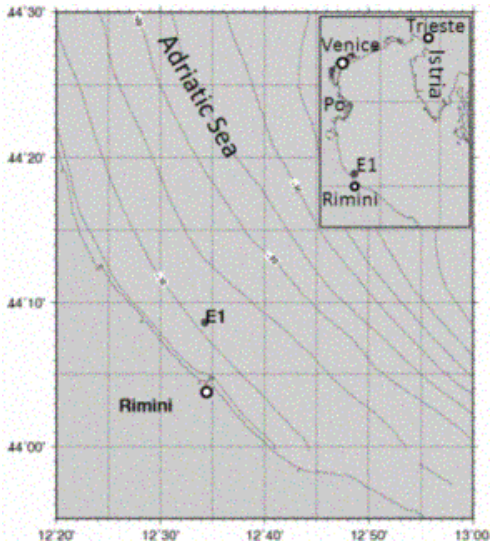


Fig. 1. Map of the study area with the E1 buoy position and the main bathymetric lines; the insert show the wider northern Adriatic area.

The European LIFE project EMMA (contract LIFE04/ENV/IT 000479) was devoted to define an observing-forecasting system, plus a Decision Supporting System relying on the information provided by the latter, in order to help local authorities in the management of such events. The project focused on the Rimini area (fig. 1), where the meteo-oceanographic buoy E1 has been deployed and it is being transmitting near real time data since August 2006 (data are showed online at http://e1.bo.ismar.cnr.it). The observing system was complemented by regular monitoring of "Daphne II" vessel of ARPA SO Daphne along the Emilia-Romagna coastal area. Additional, non-periodic cruises were being held with R/V Dallaporta and R/V Urania in order to assure the buoy maintenance and to provide *in-situ* data in a wider area (also for model initialization).

The forecasting system is based on a 3-D hydrodynamic model, the Regional Ocean Modeling System (ROMS; [2]) integrated with the Fennel (a Fasham-like) biogeochemical fluxes module (which includes dissolved oxygen and carbon dynamics). The model grid covers the whole Adriatic Sea with an horizontal resolution of 2 km and 20 *s*-levels [2] in vertical. The fluxes of heat, water and momentum through the air-sea interface are interactively computed (using the ROMS SST) from the COSMO-I7 operational atmospheric model forecasts, managed by the Hydro-Meteo-Clima Service of the Emilia-Romagna Region (ARPA-SIMC) in the framework of the Limited Area Model Italy (LAMI) agreement. Real time Po river runoff is considered by the model as a source of both freshwater and nutrients, while climatologic values are used for other rivers (as real time data are presently not available). Nutrient inputs from Emilia-Romagna coast, particularly relevant during the summer season, are simulated with 13 additional point sources. From June 2007 the system is being producing every day the forecast for the next 72 hours (according to the present time span of COSMO-I7 forecast); the current ROMS forecast is initialized by a restart file produced by the ROMS run of the day before.

Forecasts produced by the model are compared to several kind of data: temperature, salinity, dissolved oxygen time series measured by moored buoys (E1 in particular); sea level time series measured by coastal tide gauges; vertical profiles of temperature, salinity and dissolved oxygen acquired during oceanographic surveys and regular monitoring; sea surface temperature and chlorophyll measured by satellite. Statistics have been computed in order to assess the forecasting skill. It results that temperature and salinity forecast are being maintaining for over two years of integration a good correlation with measured data and a quite low Root Mean Square Error (rmse), with any data assimilation or insertion in the model. Performance of dissolved oxygen forecast is worst, with a lower correlation and a higher rmse, but most of the rmse derives from a mean bias. This should be mostly due to processes unresolved by the biogeochemical module, like benthic respiration. Work is in progress aiming to improve the system, also by including in the model simplified benthic processes; meanwhile dissolved oxygen forecasts in the Rimini area show a good performance by removing the mean bias computed from the data measured by E1 buoy during the 7 days preceding the new forecast.

To our knowledge, this is the first operational system able to produce short-term forecast of hypoxic/anoxic events in a Mediterranean Sea area.

References

1 - Vollenweider, R. A., Marchetti, R. and Viviani, R. (eds)., 1992. *Marine Coastal Eutrophication*. Elsevier, Amsterdam, 581 pp.

2 - Haidvogel D.B., Arango H., Budgell W.P., Cornuelle B.D., Curchitser E., Di Lorenzo E., Fennel K., Geyer W.R., Hermann A.J., Lanerolle L., Levin J., McWilliams J.C., Miller A.J., Moore A.M., Powell T.M., Shchepetkin A.F., Sherwood C.R., Signell R.P., Warner J.C. and Wilkin J., 2008. Ocean forecasting in terrain-following coordinates: Formulation and skill assessment of the Regional Ocean Modeling System. *J. Comput. Phys.*, 227: 3595-3624.

SELECTION OF THE PRIORITY AREAS ON THE WEST COASTS OF MERSIN USING GIS TO ASSESS A MARINE CONSERVATION PLANNING

Serdar Sakinan [1]* and Ali cemal Gucu [1]
[1] METU- Institute of Marine Sciences - serdar.sakinan@gmail.com

Abstract

The subject of this study is selection of priority areas for marine conservation planning along western coasts of Mersin, by incorporating biological and socioeconomic data through geographical information system (GIS). The geographical borders of the study area were determined by the data availability from previous surveys, which were designed to investigate Mediterranean Monk seal habitats and populations. Consequently a reserve system composed of three segments were found to be the best selection where the patches were located at west of Anamur (Mellec), surroundings of Kizilliman and Between Akkuyu and Ovacik. Along with the recommendation of priority areas for conservation, the methodology used in this study was recommended for further studies in selection of areas for protection.

Keywords: Conservation, Coastal Waters, Levantine Basin

As the important fish stocks continue to decline the need of improving protection and management of marine areas is becoming more evident and marine protected areas are viewed as important tools (Côté and Finney, 2006). The coast of Turkey holds considerable marine biodiversity and marine resources. On all along the Turkish coasts many critical habitats are sheltering endangered species and commercially important species. Despite the more noticeable efforts for the protection of the marine environment within last years, increasing exploitation of coastal regions and degradation of marine resources are emerging as important environmental threats in Turkey. Nevertheless there is still important difficulties in creating the MPAs due to the interference of different institutions in decision making and enforcement of the regulations (Okumus,2002) and lack of methodology for assessment of the coastal areas for producing conservation plans and zonation. The core issue of this study is to generate a methodology on measuring, mapping and analyzing of available marine biodiversity data and surrogates in the study area including the perturbation sources and socioeconomic conflicts, for selection of new priority areas and optimization of the borders of the present protected area. Incorporating all the available information through GIS and prioritization of the sites is the main objectives of this research.

The base data used for this study were derived from field surveys carried out on the coastal area, between Bozyazi and Ovacik. Taking into consideration of the supplementary data, the study was extended the area between Mellec and Bogsak which constitutes a 181km coastline at west of Mersin. The offshore extent of the study area was defined by the trawl data availability, which is limited within 2 nautical mile distance from coastline.

The fish assemblage of shallow coastal area within depth of 0-10m was assessed by visual census survey, covering the whole area where the stations distributed in near equal longitudinal distance. Assemblage of the demersal species of deeper waters (10-100m) was assessed by trawl sampling. Considering the difficulty of measuring whole biodiversity of the area, surrogates were used to represent biodiversity. Surrogates were coastal habitat types, endangered species habitats and some certain fish species data derived from trawl and visual census data sets. Socioeconomic information was also collected during the surveys which were combined with the information extracted from Google Earth satellite images later on. All the obtained data was combined under a geo-database and mapped using GIS. After creation of the data layers Marxan was employed for site selection. Marxan is software designed for selection of the areas for creating marine reserves. With Marxan, it is possible to include socioeconomic information and optimize borders of the reserve system to provide compactness. The strength of the software is the simulated annealing algorithm by which Marxan finds optimal solutions. Several different tests were applied to find suitable values for settings of the software. Afterwards 8 different scenarios were created by changing the representation targets for each conservation feature. Finally a set of different sized but similarly located reserve systems were defined.

Consideration of multiple factors including cost, socioeconomic environment of the area is required along with the ecological factors. The biggest problem is to find an optimal solution that provides the best balance of biodiversity and socioeconomic concerns. The Kizilliman Marine Protected Area is designated to restore the marine ecosystem deteriorated by excess fishing pressure. Since the ultimate goal of this work is to optimize the conservation measures in the MPA analysis have basically focused on the fish communities and use it as a tool for supporting conservation site prioritization. Moreover considering the insufficiency of fish data for site prioritization, supplementary information such as critical habitats and coastline structure were used. As being one of the basic components of the decision making process the socioeconomic structure of the area was also assessed and incorporated in the analysis.

The framework was constructed to place two predefined critical zones at core of reserve system, which are most effective whelping sites of the Mediterranean monk seals in Turkish seas. With the aid of GIS and Marxan this aim was achieved by including the rest of the available biologic and socioeconomic information where the size and borders were optimized. Additionally a new zone located at neighborhoods of Akkuyu and Ovacik was identified as priority area. Finally two kinds of results were generated: best solution and irreplaceability. While decision of locating the protected areas was accomplished by best solutions, the irreplaceability values were essential for classifying the importance of the zonation and identifying the hotspots.

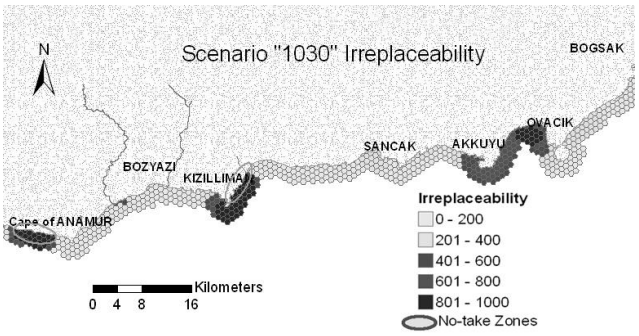


Fig. 1. Best scenario with irrepleacebility values

Consequently a reserve system was selected consisting of three regions. The regions were located at Anamur, Bozyazi and Ovacik. Moreover Akkuyu region where the nuclear power plant construction is on focus , found to be located in one of the core area of the reserve system assessed by this study. This result shows that a need for reassessment for the location of power plant need to be done, considering the possible negative effects of the nuclear power plants, over ecosystems.

References

1 - Ball, Ian and Possingham, Hugh, 2000. MARXAN (v1.8.2): Marine Reserve Design Using Spatially Explicit Annealing. A Manual Prepared for the Great Barrier Reef Marine Park Authority. 69 pp.

2 - Bohnsack, J.A., 1998. Application ofmarine reserves to reef fisheries management. Australian Journal of Ecology 23: 298–304.

3 - Gucu, A.C., Erkan, F., 1999. Preliminary survey report of the monitoring project on the recovery rate of a once deteriorated ecosystem recently designated as a protected area - Phase I. Detrimental Effects Of Trawl Fishery On The Fish Stocks On A Narrow Continental Shelf. Unpublished report to Turkish Ministry of Agriculture and Rural Affairs (in Turkish).

4 - Kelleher, G., 1999., Guidelines for Marine Protected Areas. World Commission on Protected Areas, Gland, Switzerland 127pp.

5 - Côté F., Finney J, 2006 Marine Protected Areas: An Essential Element Of The Fisheries Management Toolbox Canada Library of Parliament, 16p. Parliamentary Information and Research Service (PIRS)

6 - Okumus K.2002. Turkey's Environment, A Review and Evaluation of Turkey's Environment and its Stakeholders The Regional Environmental Center for Central and Eastern Europe, European 44 pp.

REPARTITION DES POLYPLACOPHORES DANS LE LAC NORD DE TUNIS ET CARACTERISATION MORPHOMETRIQUE DE L'ESPECE DOMINANTE *LEPIDOCHITONA CAPREARUM* (SCACCHI, 1836)

Hedi Salah [1] and Nejla Aloui Bejaoui [1]*

[1] Institut National Agronomique de Tunisie, Sfax, 3050, Tunisie - bejaoui.nejla@inat.agrinet.tn

Abstract

Cette première étude écobiologique sur les Polyplacophores de Tunisie met en évidence la présence de trois espèces sur le substrat rocheux de la digue centrale du lac Nord de Tunis après son aménagement en 1988. L'analyse en composantes principales des paramètres métriques de l'espèce dominante *L.caprearum* révèle l'existence de deux groupes d'individus. Cette ségrégation reflète l'influence des paramètres abiotiques, en particulier des teneurs en sels nutritifs, sur la morphologie de ces Mollusques.

Keywords: Mollusca, Rocky Shores, Lagoons, Growth

Introduction

Les Polyplacophores présentent une large répartition en Méditerranée [1] mais n'ont pas fait l'objet d'études en Tunisie. Ce travail est une contribution à la connaissance de leur écologie en particulier au niveau de la digue centrale du lac où leur abondance a augmenté après l'amélioration des conditions hydrodynamiques de ce milieu lagunaire.

Matériel et méthodes

L'étude a été réalisée entre octobre 2007 et juillet 2008. Six aires, d'une profondeur maximale de 50 cm, ont été sélectionnées sur la digue. Les aires A1, A2, A3 sont situées sur la frange côtière Nord et sont soumises aux apports d'eau de mer alors que A4, A5, A6 sont situées au sud et sont représentatives d'un milieu lagunaire dont les eaux, sortantes vers la mer, sont chargées en sels nutritifs. Des prélèvements mensuels, dans chacune des aires, de l'espèce dominante *L. caprearum* ont permis de réaliser une étude morphométrique dont le but est d'identifier l'influence des paramètres du milieu sur la distribution et les caractéristiques morphologiques de l'espèce.

Résultats et discussion

Sur les trois espèces identifiées *Lepidochitona caprearum*, *Lepidochitona cinerea* et *Chiton olivaceus*, *L. caprearum* est la plus représentée en terme d'abondance à l'intérieur de chacune des aires. La répartition de ces espèces sur la digue centrale du lac montre que *L. caprearum* est présente dans l'ensemble des sites prospectés à l'exception de la 4e aire (Fig. 1).

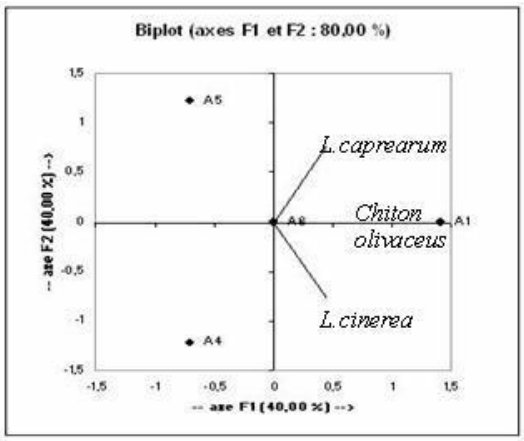


Fig. 1. Répartition des espèces recensées dans les différentes aires d'études sur les deux premiers axes de l'analyse en composantes principales (ACP)

En effet, au niveau de l'aire 4, les valeurs moyennes de la matière en suspension (30,3 ± 9,81 mg/l) et du phosphore total (35, 65 ± 7,87 µg/l) sont les plus élevées et celle de l'O_2 (8,54 ± 5,5 mg/l) est la plus faible. Ces résultats confirment l'influence de la turbidité sur la répartition des Polyplacophores, mise en évidence par Zavodnik *et al.* [2]. *L. cinerea* est l'espèce la mieux repartie sur l'ensemble des aires étudiées. *Chiton olivaceus* est au contraire une espèce à affinité marine, présente seulement dans l'aire 1. La répartition de ces espèces, obéit, comme toute espèce lagunaire [3], à l'influence de la salinité, de la profondeur et du degré de confinement. L'ACP des données relatives à la longueur antéro-postérieure, à la largeur et à l'épaisseur et, portant sur un effectif total de 652 individus de *L.caprearum*, montre deux nuages de points (Fig. 2).

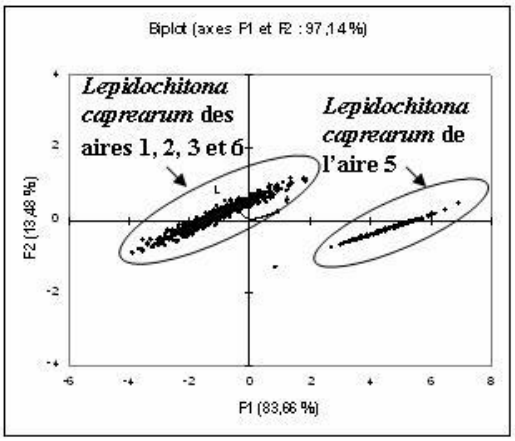


Fig. 2. Représentation graphique des différents échantillons de *Lepidochitona caprearum* sur les deux premiers axes de l'ACP des paramètres métriques

Le premier super groupe met en évidence une forte agrégation entre les différents spécimens des aires 1, 2, 3 et 6. Le nuage de points de la 5e aire est indépendant de ces échantillons. La largeur et l'épaisseur sont les variables les plus discriminantes dans la séparation de ces deux groupes. L'aire 5 est caractérisée par une charge trophique supplémentaire liée à la présence de pêcheries d'anguilles. Baxter et Jones [4] ont souligné le rôle de la charge trophique, en particulier sur les Polyplacophores. D'autres facteurs physico-chimiques peuvent expliquer par ailleurs les variations observées et confirment cette influence déjà bien mise en évidence par Boolootain [5]. Les individus présentent en effet une croissance optimale dans l'aire 5.

Conclusion

L'étude des Polyplacophores dans le lac Nord a mis en évidence les limites de tolérance de ces espèces vis-à-vis des conditions abiotiques ainsi que l'influence des facteurs trophiques dans la croissance morphométrique de *L. caprearum* de l'aire 5.

References

1 - Dell'Angelo B. and Smriglio C., 2001. Living chitons from the Mediterranean sea, Rome: 255p.

2 - Zavodnik D., Pallaodo A., Jaklin A., Kovacic A. and Arko-Pijevac M ., 2005.A benthos survey of the Senj Archipelago (North Adriatic Sea, Croatia). *Actat Adriat.*, 46 (Suppl. 2): 3 - 68.

3 - Basset A., Galuppo N. and Sabette L., 2006. Environmental heterogeneity and benthic macroinvertebrate guilds in Italian lagoons. *Transit. Waters Bull.*, 1: 48 - 63.

4 - Baxter J.M. and Jones A. M., 1978. Growth and Population Structure of *Lepidochitona cinereus* (Mollusca: Polyplacophora)Infected with *Minchinia chitonis* (Protozoa: Sporozoa) at Easthaven, Scotland. *Marine Biology*, 46: 305 - 313.

5 - Boolootain R.A., 1964. On growth and reproduction in the chiton *Mopalia muscosa* of Santa Monica Bay. *Helgoländer wiss Meeresuntersuchungen*, 11: 186 - 199.

JUVENILE FEEDING HABITS OF MUGILIDAE SPECIES FROM ESTUARINE SYSTEMS IN NORTH AEGEAN SEA

Ioanna Salvarina [1], Manos Koutrakis [1]* and Ioannis Leonardos [2]
[1] NAGREF - Fisheries Research Institute - manosk@inale.gr
[2] Biological Applications & Technology Dep., Univ. of Ioannina, 45110 Greece

Abstract
The feeding preferences of 823 juvenile fishes belonging to five species of the Mugilidae family from Strymonikos Gulf estuarine systems were analyzed. A similar feeding strategy pattern was found for all species, except *M. cephalus*, which had one dominant food category.
Keywords: Diet, Estuaries, Fishes

Strymonikos Gulf is one of the richest fishing grounds in North Aegean Sea. The fish biodiversity observed in Strymonikos estuaries is among the highest recorded in the Mediterranean Sea [1]. Many studies have been conducted concerning fish fauna [1] and other aspects of the area [e.g. 2]. This is the first study of feeding habits of Mugilidae species in the Greek area.

Materials & Methods

Samplings were carried out, using a bag seine net (12 m length, 3 mm bar mesh size), on a monthly basis from September 1997 to May 1999, in two sampling stations in each estuarine system of Strymonikos Gulf (Rihios and Strymon). Stomach content was analyzed using the percentage volumetric composition and the percentage of frequency of occurrence of each food category [3]. The vacuity index was also estimated for each species as VI% = (number of empty stomachs) / (total number of stomachs examined) *100. To determine the feeding strategy of the species the modified Costello graphical method [4] was used. Analysis of covariance (ANCOVA) was performed to compare the volume of gut content among sampling sites and seasons.

Results & Discussion

A total of 823 specimens (Total Length: 14–130 mm) belonging to species *Chelon labrosus*, *Liza aurata*, *L. ramada*, *L. saliens* and *Mugil cephalus* were examined for their diet composition. The total vacuity index was 28.19%. *L. aurata* had the lowest vacuity index (18.15%) and *M. cephalus* the greatest (41.21%). The main food categories that were found in volume contribution of individual species diet included: phytoplankton (33%), amphipods (26%) and detritus (19%) for *C. labrosus*, mysids (40%), copepods (17%) and amphipods (16%) for *L. aurata*, phytoplankton (28%) and aquatic vegetation (20%) for *L. ramada*, phytoplankton (39%) and amphipods (31%) for *L.saliens* and phytoplankton (88%) for *M. cephalus*. A similar feeding strategy pattern, with varying degree of specialization, was followed by all species, except *M. cephalus*, which had one dominant food category (phytoplankton) (Fig. 1).

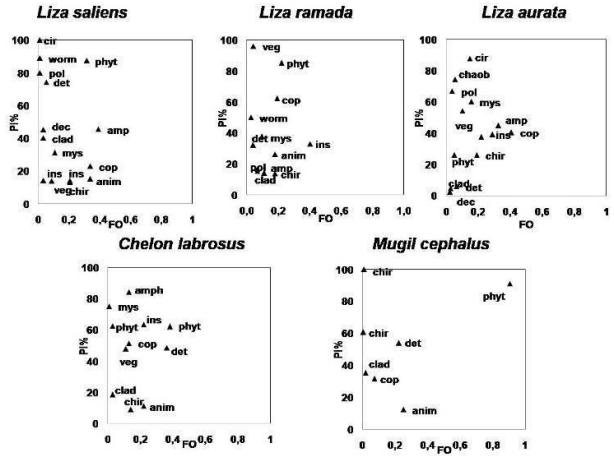


Fig. 1. Relationship among prey specific abundance (Pi%) and frequency of occurrence (FO) of food categories of Mugilidae species. Plots based on the modified Costello method [4]. (amp: amphipoda, cop: copepods, mys: mysids, anim: other animals, ins: unidentified insects, clad: cladocerans, det: detritus, chir: chironomids, phyt: phytoplankton, veg: aquatic vegetation, pol: polychaets, worm: other worms, dec: decapods, chaob: chaobors, cir: cirripedia).

References
1 - Koutrakis E.T., A.K. Kokkinakis, A.E. Eleftheriadis & D.M. Argyropoulou., 2000. Seasonal changes in distribution and abundance of the fish fauna in the two estuarine systems of Strymonikos Gulf (Macedonia, Greece). Belgian *J. of Zoology*, 130: 41-48.
2 - Koutrakis, E., Lazaridou, Th. and Argyropoulou, M.D., 2002. Promoting Integrated Management in the Strymonikos Coastal Zone (Greece): A Step-by-Step Process. *Coastal Management* 31: 195-200.
3 - Hyslop, E.J., 1980. Stomach content analysis- a review of methods and their application. *Fish Biol.* 17: 411-429.
4 - Amundsen, P.A., Gabler, H.M. and Staldvik, F.J., 1996. A new approach to graphical analysis of feeding strategy from stomach contentes data-modification of the Costello (1990) method. *J. Fish Biol.* 48: 607-614.

RUN-UP ALONG EMBAYED BEACHES DURING STORMS (BARCELONA, NW MEDITERRANEAN)

Amanda Sancho garcía [1]* and Jorge Guillén [1]
[1] INSTITUTO DE CIENCIAS DEL MAR (CSIC) - asancho@icm.csic.es

Abstract

In this study, we analyze the displacement of the waterline associated to the run-up produced during storms at three beaches of Barcelona city. Video images measurements of the run-up were carried out during the most energetic storms between 2001 and 2008. Wave run-up observations are then compared with a run-up related parameter, which takes into account wave characteristics and beach foreshore slope, in order to obtain an equation that can be used to predict the run-up along these beaches.

Keywords: Beach, Shoreline Evolution

A significant portion of the population lives in coastal areas that are exposed to different hazards such as flooding and coastal erosion. Flooding at the emerged beach during storm conditions is very common in Mediterranean coasts. In Barcelona beaches (NW Mediterranean) these events produce important damages in the coastal structures (i.e. promenade, showers, etc). In this study, three Barcelona beaches have been studied: La Barceloneta, Somorrostro and Nova Icaria (Fig. 1). These are artificial embayed beaches with steep slopes, and are protected with coastal structures. In order to quantify the run-up, the effect of the most energetic storms on theses beaches was evaluated from 2001 to 2008. In total, fifteen storm events were analyzed, all with Hs higher than 3 m during the peak of the storm.

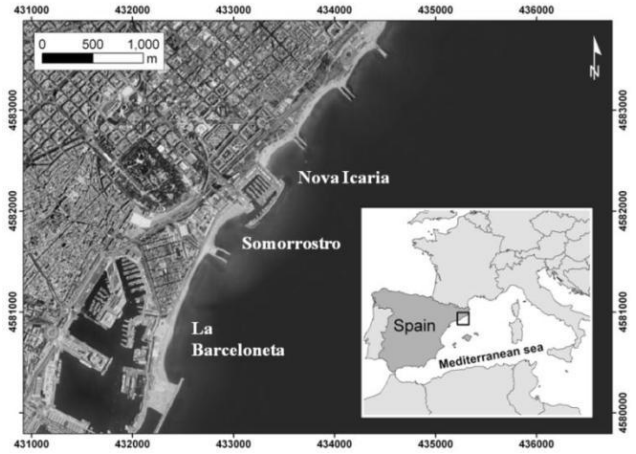


Fig. 1. Localization of Somorrostro, La Barcelona and Nova Icaria beaches(NW Mediterranean)

For each storm event, the hourly waterline position of each beach was obtained from the 10-minute time exposure images by means of an Argus video system [1]. The video system is located atop a building close to the Olympic Marina at a height of around 142 m, and it is composed of five cameras pointing at the beaches and offering a 180° view of the coast (images available at: http://elb.cmima.csic.es). A reference waterline was defined for each beach and storm as the result of the averaged position from all available waterlines of each storm event. The horizontal component of the run-up was obtained using lines perpendicular to this reference waterline. The results show values of the maximum about 50 m in emerged beach area of La Barceloneta (Fig. 2), 30 m in Somorrostro and 40 m in Nova Icaria are flooded during storms. However flooding is not homogeneous along the beach.

In order to obtain a predictive tool for the run-up in Barcelona beaches, the observed displacement of the waterline at each profile along the beach during the storm (D), was related with a runup-related parameter (F), which includes wave characteristics (significant wave height, H_s, and wave length, L_o), mean sea level (MSL) and beach foreshore slope (tanβ) and represents the horizontal component of the run-up as:

$$F = \sqrt{H_s L_o} + \frac{MSL}{\tan\beta}$$

In general, a significant correlation was found between both parameters. The fit is better in Somorrostro (best fit, $R^2 = 0.50$), than in La Barceloneta (best fit, $R^2 = 0.40$) and Nova Icaria (best fit, $R^2 = 0.27$).

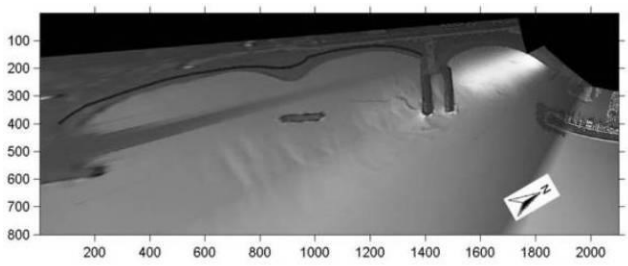


Fig. 2. Picture of La Barceloneta beach on 25th December 2008. The line shows the waterline position at the peak of the storm (27/12/2008). Coordinates are given in metres measured from a local zero

In conclusion, video-monitoring provides detailed information of run-up during storm events. This data can be used to improve the predictive character of the general run-up equations and give useful information for coastal management.

Acknowledgments : This work was funded by the Spanish Ministry of Science and Technology within the SEDMET project (CTM2006-06919). The first author is supported by a JAE-predoc scholarship from the CSIC. Video images were provided by the Coastal Ocean Observatory (ICM-CSIC).

References

1 - Holman, R.A., Stanley, J., 2007. The history and technical capabilities of Argus. *Coastal Engineering*, 54, 447–491.

MEDITERRANEAN MARINE AND COASTAL ECOSYSTEMS: AN ECONOMIC VALUATION

Didier Sauzade [2]*, Anaï Mangos [2] and Jean-pascal Bassino [1]
[1] University Montpellier III
[2] Plan Bleu - dsauzade@planbleu.org

Abstract

This study proposes a first exploration at the scale of the 22 Mediterranean countries of the economic value of sustainable benefits to society provided yearly by marine and coastal ecosystems. The methodology is adapted from the System for Environmental and Economic Accounting of the United Nations. Using available data at national and regional level, total benefits for all the riparian countries are estimated at 29.4 billion €, i.e. 15% of Greek Gross National Income (GNI), or 130 % of Tunisian GNI.
Keywords: Coastal Management, Economic valuation, Ecosystem services, Eastern Mediterranean, Western Mediterranean

Blue Plan (UNEP/MAP), whose mission is to inform stakeholders for sustainable development in the 22 Mediterranean countries, has been entrusted to assess the economic value of benefits provided by Mediterranean marine and coastal ecosystems. The objectives are to enhance awareness of these benefits to society and offer policy makers a common metric for better management [1].

Materiel and methods

Benefits provided by ecosystems to people are obtained from ecological services (Tab. 1), following a widely accepted classification. The economic valuation method used is adapted from SEEA [3] and is restricted to sustainable and direct benefits (e.g. fishing excluding over fishing and seafood processing). Estimation of benefits is based on computable substitutes, or proxy values (see Tab. 2) computed for the reference year 2005 using available ecosystem characteristics and national or regional level data extracted from various public databases (Fishstat, Labor-stat, UNdata, AQUASTAT, Eurostat…) such as fish catches, value added (VA), labor force... Various value transfer methods had been used when necessary. All calculations are available.

Tab. 1. List of the estimated benefits, adapted from [2]

Category	Ecological services	Estimated benefits
Production services	Food production	Resource rent of fisheries & aquaculture
	Raw materials	Resource rent of marine sand extraction
Regulation services	Gas & climate regulation	Global climate regulation (value of CO_2 sequestration)
		Regional climate regulation (value of rainfall due to sea evaporation)
	Disturbance prevention	Coastal protection due to *Posidonia* meadows
	Bioremediation of waste	Storage, burial & recycling of waste water
Cultural services	Leisure and recreation	Resource rent of tourism, hotels & restaurants and real estate in coastal areas
	Cognitive benefits Cultural heritage & identity Future unknown & speculative benefits	Not counted
Support services	Various supports to other ecological services	Not counted to avoid double counting

In short, the resource rent of fisheries and aquaculture was estimated on the sector VA, overfishing and other non sustainable practices being expressed by an overall coefficient valued to 80% derived from [4]. Resource rent for tourism, hotels, restaurants and real estate was evaluated at 5% of their VA in coastal areas through a multiple regression analysis of the coastal attractive effect computed on NUTS-3 Eurostat data. Erosion protection was appraised on the basis of the avoided coastal protection expenditures for approximately 1000 km of coast length, this figure being derived from available data on coastal erosion, protections in place, and presence of *Posidonia* meadows. Global climate regulation was estimated from recent data on the amount of anthropogenic CO_2 sequestrated by the Mediterranean sea [5] and the average value of the carbon market. Value of the rainfall water evaporated from the Mediterranean Sea was estimated on the basis of quantities derived from [6], [7] and a shadow price for the agricultural water in Morocco given by [8]. Sustainability constraint was specially constraining for the estimation of the waste treatment, the benefit of which was valued considering the consumption of domestic water and the amount of a pollution compensation fee deducted in a real French situation considered as sustainable.

Results

Main results are summarized in table 2, giving a total amount of 29,4 billion €, *i.e.* 15% of Greek GNI or 130% of Tunisian GNI. A focus has been made on two countries, Greece and Tunisia, giving respectively 3,2 and 0,6 billion € or 2% and 3% of their GNI.

Discussion and conclusion

Results of this exploratory study show that the restriction to sustainable uses of ecosystem services leads to underestimation of benefits. Full application of the SEEA framework to marine and coastal ecosystems would require an extensive data base not presently available. Future extension of the work may concern coverage to additional sectors such as marine transportation or sand extraction. Benefits provided by remarkable ecosystems like *Posidonia* meadows could be also investigated, beyond the coastal protection service.

Tab. 2. Estimated values of the benefits provided by Mediterranean marine and coastal ecosystems

Benefits	Proxy values	Values (M €)
Fisheries and aquaculture	VA x Sustainability coefficient (=0.8)	2 869
Hotels and restaurants	5% VA in coastal areas	4 133
International tourism	5% VA in coastal areas	3 804
Real estate in coastal areas	5% housing expenditure	11 198
Erosion protection	Coastal protection expenditures avoided	530
Global climate regulation	Sequestrated anthropogenic CO_2 by value of CO_2 ton	2 220
Regional climate regulation	Rainfall agricultural water by water shadow price	2 490
Waste treatment	Domestic water by pollution compensation fee	2 570
Total benefits (year 2005) :		**29 814**

References

1 - CIESM., 2008. Economic valuation of natural coastal and marine ecosystems, *Workshop Monographs* n°37, Bodrum (Turkey), 22 - 25 October 2008, 112 p.

2 - Beaumont, N.J., *et al*., 2007. Identification, definition and quantification of goods and services provided by marine biodiversity: Implications for the ecosystem approach, *Marine Pollution Bulletin*, 54, 253–265.

3 - United Nations., 2003. Handbook of National Accounting: Integrated Environmental and Economic Accounting.

4 - CGPM, 2008, General Fisheries Commission for the Mediterranean, report of the eleventh session of the Scientific Advisory Committee, Marrakech, Morocco, December 2008.

5 - Huertas, I.E. *et al*, 2009., Anthropogenic and natural CO2 exchange through the Strait of Gibraltar, *Biogeosciences Discuss*., 6, 1021–1067.

6 - Mariotti A. *& al*., 2001, The Hydrological Cycle in the Mediterranean Region and Implications for the Water Budget of the Mediterranean Sea, *Journal of climate*,15.

7 - Margat, J., Plan Bleu., 2008. L'eau des Méditerranéens: situation et perspectives. France. L'Harmattan.

8 - Bouhia, H., 2001. Water in the Macro Economy, Integrating economics and engineering into an analytical model, Ashgate Publishing Limited, Burlington USA, pp 35-52 and 90-94.

ASSESSMENT OF CHEMICAL CONTAMINATION OF MALTA AND LAMPEDUSA COASTAL WATERS BY MEANS OF ACTIVE MUSSEL WATCH

A. Scarpato [1]*, G. Romanelli [1], E. Azzurro [1], M. Amici [1], V. Perini [1], A. Cozzolino [1], F. Novelli [1], R. Di mento [1], R. Parravano [1], P. Giordano [1], R. Piermarini [1], A. Cento [2] and V. Axiak [3]

[1] ISPRA, Istituto Superiore per la Protezione e la Ricerca Ambientale, 00166, Rome, Italy - alfonso.scarpato@isprambiente.it

[2] PSTS S.c.p.a., Parco Scientifico e Tecnologico della Sicilia, 95030 Catania, Italy

[3] Department of Biology, University of Malta, 2080

Abstract

In the frame of Italia-Malta community initiative program (the 'MonItaMal' project), the active mussel watch was used to evaluate the chemical contamination of Malta, Lampedusa and Linosa coastal waters. This study was carried out during 2006-2007 together with analysis of sediments. The concentration of heavy metals, TBT, PHs, DDTs,PCBs, and pesticides was assessed, providing a snapshot of the contamination levels in the Sicily channel.

Keywords: Bivalves, Chemical Analysis, Monitoring

Introduction

The mussel watch methodology is a widely used technique to monitor the levels of a large array of contaminants and biochemical parameters in marine coastal waters [1]. It is based on the ability of the mussels to concentrate chemical contaminants in their tissues in relation to their presence in the environment. Monitoring the quality of the coastal marine environment is an action recommended by the European Union, together with the preservation of habitats and their biodiversity. Malta and Lampedusa belong to different countries, but these two islands are located in the same geographical sector, the Sicily channel, and the adoption of common methodologies for environmental control is strongly advised by the UE.

Materials and methods

During 2006-2007, according with a standardized mussel watch protocol, a total of 43 mussel cages were deployed in 11 locations subjected to a different anthropogenic impact. In Malta, the mussel locations were in proximity of the marine protected area of Gnejna, close to sewage outfalls of Cumnija and Xghajra; in Lampedusa, locations were in proximity of the main harbor and within the protected area (A zone); in Linosa, an island characterized by a minimum anthropogenic pressure, 2 locations were considered (Fig.1).

Sediments and water samples were analyzed in order to fully characterize the study areas. Analyses ofPAHs (16 EPA), PCBs (10 congeners), OC pesticides (pp'-DDT and its metabolites, HCHs, HCB, Aldrin, Dieldrin), heavy metals (Hg, Cd, Pb, Cu, Zn), TBT on mussel and sediment were realized by means of standardized laboratory methods.

Results and Discussion

Mussel cages recovery was of 70%. Results of heavy metals analysis were generally comparable between the three island, with no significant differences between Lampedusa Malta and Linosa. However, high levels of contaminants were found in correspondence of Xghajra (Malta), were metals, especially Hg, Pb e CU, had higher concentrations (up to ten times higher) with respect to background levels [1].

Mean TBT levels resulted of 2.53ng Sn/g w.w. In Malta, 0.43ng Sn/g w.w. at Lampedusa whilst in Linosa these compounds were not detected. Their degradation products (DBT e MBT) resulted to be significantly higher in Malta than in Lampedusa and Linosa.

PCB and pesticide contamination appeared to be low in both islands with levels comparable to the ones of Linosa. The maximum concentration of PCBs was of 30 ng/g d.w..

As for DDTs, the metabolites DDD and DDE were the main components. On the whole, the mean DDTs levels of Malta and Lampedusa (the maximum value was of 13-14 ng/g d.w. on both islands) confirmed those obtained from other mussel watch projects that used the same methodology in the same study area [1]. Nevertheless in correspondence of Xghajra, concentrations of 8 ng/g d.w. were detected. Similar levels of DDTs are known for highly polluted areas such as Naples, Barcelona and Marseille (Scarpato, unpublished data). Sediment analyses confirmed the mussel watch results, with the area of Xghajra presenting the highest values for metals (especially Hg and Cu), TBT and related degradation products (DBT and MBT).

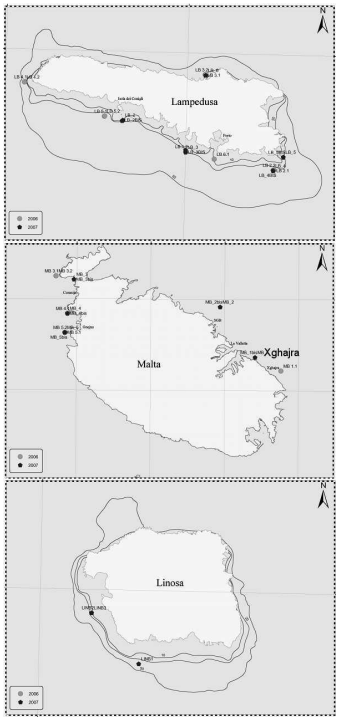


Fig. 1. Sampling stations

References

1 - [1]. Andral B., Stanisiere J.Y., Sauzade D., Damier E., Thebault H., Galgani F. and Boissery P., 2004. Monitoring chemical contamination levels in the Mediterranean based on the use of mussel caging. *Mar Pol Bull*, 49: 704-712.

EFFECTS OF THE LOSS OF *PARAMURICEA CLAVATA* (RISSO, 1826) FORESTS ON CORALLIGENOUS ASSEMBLAGES

A. Scinto [1], M. Bertolino [2], C. Huete-stauffer [1], M. Previati [1]*, T. Romagnoli [2], L. Valisano [2] and C. Cerrano [1]
[1] DIPTERIS, Genoa University, Genoa, Italy - m.previati@email.it
[2] DISMAR, Polytechnic University of Marche, Ancona, Italy

Abstract
Arborescent benthic species, both algal and animal, define the architecture and functional ecology of certain "forest" structures. Such ecosystem engineers (foundation) species are declining throughout the world due to anthropic activities and/or global warming, leading to introductions and outbreaks of pests and pathogens. The case study of *Paramuricea clavata* here reported shows how the loss of the biggest foundation species of coralligenous assemblages may compromise the accretion processes of coralligenous reducing the presence of some calcifying species such as coralline algae and bryozoans.
Keywords: Biodiversity, Global Change, Mortality

Introduction
During recent years climate warming and thermal anomalies are negatively affecting the survivor of marine benthic species, resulting in diseases and pathogens spreading, whose effects, always sudden and dramatic, lead to reductions in biomass of several filter feeders, sponges and gorgonians ([1], [2]). Considering gorgonians as engineering species able to shape the architecture and increase the complexity or influence the biogeochemistry of habitats, it is evident that a decrease in the population negatively affects habitat heterogeneity and biodiversity [3]. Here we investigate the effects of the loss of *P. clavata* colonies on coralligenous accretions focusing mainly on coralline algae and bryozoans.

Method
Six plastic panels 15x10 cm^2 size were positioned inside and outside a gorgonian forest on the Portofino Promontory cliff (Ligurian Sea, Italy) to evidence possible effects of sea fans on the dynamics of colonization of a substratum. After the collection of the panels, four months after positioning (from May to September 2009), they were dry preserved and analysed at the stereomicroscope by a grid with a mesh of $1cm^2$. Data were arc-sin transformed and analysed with Cochran's Test, ANOVA and SNK Test.

Results
Regarding coralline algae, four different morphotypes of newly settled Corallina *species* and three of *Peyssonelia* have been separated (Fig.1). Algae showed different frequencies in panels inside and outside gorgonians populations (20.3±2.8 and 18.2±2.4 inside and outside respectively) (ANOVA, P=0.0041) and the unique morphotype that presented differences in frequencies between inside and outside is the one we call *Corallina* sp. 2 (SNK, P<0.01), more abundant inside (15.1±5.3 and 1.6±0.9 respectivaly) , while the other species showed similar frequencies. Regarding Bryozoa, inside gorgonian forest seven species of Bryozoa have been found, three of them exclusively inside (Fig.2). The Shannon diversity index underlines a major diversity in species inside the gorgonian forests (2.9±0.1 and 2.7± 0.04 inside and outside respectively) (One-way ANOVA, P=0.02).

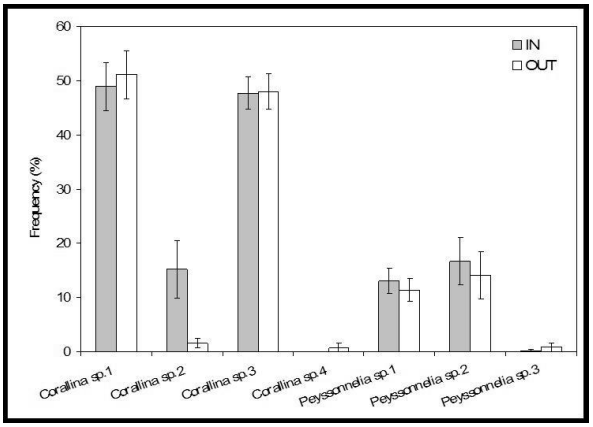


Fig. 1. Different *Corallina* and *Peyssonelia* unidentified species inside and outside the gorgonian forest

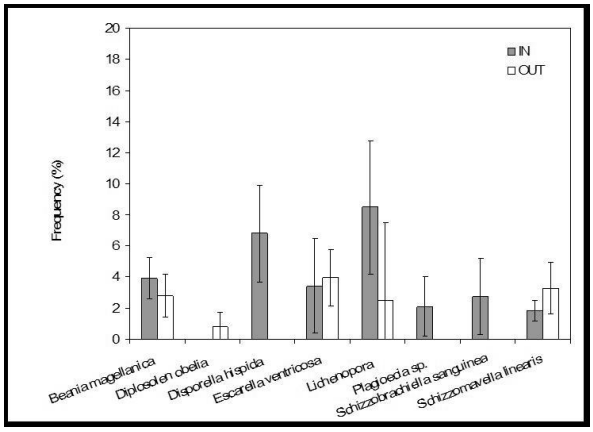


Fig. 2. Different species of bryozoans observed inside and outside of the Gorgonian forest

Discussion
The loss of foundation species changes the local abiotic and biotic environment on which a variety of other species depend [3]. One of the most dramatic example in the Mediterranean Sea is the rapid loss of sponge gardens and gorgonian forests [1]. The decrease of *P. clavata* colonies from coralligenous accretions will lead to a shift from a dim-light environment (optimal for some Corallinales) to a light exposed one. The negative effect we noticed towards some bryozoans may be also due to the reduction of a sort of physical protection played by sea-fans on rigid colonies. The studied area host high touristic fluxes of scuba divers, whose activities can have an impact on some sessile species.
These dynamics are rapidly changing shallow (0-40 m) coastal habitats seascapes, with unpredictable effects on marine trophic webs.

References
1 - Garrabou J., Coma R., Benssousan N., Bally M., Chevaldonne P., Cigliano M., Diaz D., Harmelin J.G., Gambi M.C., Kersting D.K., Ledoux J.B., Lejeusne C., Linares C., Marschal C., Perez T., Ribes M., Romano J.C., Serrano E., Teixido N., Torrents O., Zabala M., Zuberer F. and Cerrano C., 2009. Mass Mortality event in NW Mediterranean rocky benthic communities: effects of the 2003 heat wave. *Global Ch. Biol.*, 15:1090-1103
2 - Cerrano C., Bavestrello G., Bianchi C.N., Cattaneo-Vietti R., Bava S., Moranti C., Morri C., Picco P., Sara G., Siccardi A. and Sponga F., 2000. A catastrophic mass-mortality episode of gorgonians and other organisms in the Ligurian Sea (Northwestern Mediterranean), summer 1999. *Ecol. Lett.*, 3 : 284-293
3 - Cerrano C., Danovaro R., Gambi C., Pusceddu A., Riva A. and Schiaparelli S., 2010. Gold coral (*Savalia savaglia*) and gorgonian forests enhance benthic biodiversity and ecosystem functioning in the mesophotic zone. *Biodiv. Conserv*., 19: 153-167.

COMMUNAUTÉ ACTUELLE DE CRABES (BRACHYURA, DECAPODA, CRUSTACEA, ARTROPODEA) DE LA LAGUNE DE BIZERTE (TUNISIE SEPTENTRIONALE)

Moez Shaiek [1]*, Mohamed salah Romdhane [1] and Amel Ben Rejeb Jenhani [1]

[1] Unité de recherche Ecosystèmes et Ressources Aquatiques, Institut National Agronomique de Tunisie, Tunis, 1082, Tunisie - shaiekmoez@yahoo.fr

Abstract

Nous avons réalisé des prospections durant la période s'étendant de mois de juillet à novembre 2009 au niveau de la lagune de Bizerte visant les crabes présents. Ainsi, ces compagnes ont révélé la présence d'*Eucrate crenata* et son installation définitive dans cette lagune. Ces mêmes prospections révèle la présence des espèces *Parthenope angulifrons* et *Xantho poressa*, au coté la persistance des quatre autres espèces classiques de ce milieu à savoir; *Carcinus aestuarii, Pilumnus hirtellus, Maja squinado* et *Ilia nucleus*. Enfin, on signale la présence du crabe de roche *Pachygrapsus marmoratus* au niveau du canal de Bizerte et de son goulet, sa présence lagunaire reste très probable.

Keywords: Decapoda, Crustacea, Lagoons, Zoobenthos, Gulf Of Gabes

Introduction

La lagune de Bizerte est directement reliée à la mer méditerranéenne via le canal de Bizerte, ce qui lui doit ses caractéristiques biotiques et abiotiques plus proche du milieu marin que le milieu lacustre ; Elle est constamment soumise aux différents flux hydro-biologiques. Ainsi, ce milieu connaît depuis longtemps des flux d'échanges d'espèces animales et végétales, qui sont accélérés par les bouleversements hydrologiques (mise en place de plusieurs ouvres et barrages sur les affluents de la lagune) et surtout par le trafic maritime caractérisant le canal de Bizerte, son port commercial ainsi que la lagune où séjourne à longueur de l'année les navires de toutes les provenances attendant leur tour pour des travaux de carénage et de réparation, au niveau de la rive Sud-Ouest de la lagune.

Matériel et méthode

Au cours de cette étude, nous avons pu capturé les différentes espèces de crabes, au moyen de filets trémails conventionnelles, dont les mailles sont de 26mm/80mm/26mm. Les filets ont été mises à l'eau pendant 24h00, avant de les tirer à bord de l'embarcation et de repêchés les différentes espèces de crabes. Ainsi, nous avons réalisé des points de pêche de façon à couvrir le maximum de la superficie de la lagune et durant la période s'étendant de juillet à novembre 2009. Enfin, nous avons été aidés par les témoignages des pêcheurs locaux, en ce qui concerne 'existence l et l'apparition des espèces de décapodes recensées. **Résultats des prospections** Cette investigation ciblant la communauté de crabes dans la lagune de Bizerte nous a permis de confirmer la présence des espèces suivantes; *Carcinus aestuarii* (Nardo, 1847); C'est l'une des espèces littorale et sublittorale de crabes les plus caractéristiques de la méditerranée et en particulier les lagunes saumâtres tel la lagune de Bizerte. L'abondance de ce crabe dans les eaux littorales peu profondes peut être considérée comme indicatrice de pollution [3]. Ainsi, cette espèce se révèle la plus abondante au niveau de la lagune de Bizerte, ce qui confirme l'état de anthropisation et d'eutrophisation de ce milieu, en particulier au niveau de zones de balancement des marées et les zones à forte urbanisation. *Pilumnus hirtellus* (Linnaeus, 1761); Cette espèce remarquable par sa pilosité été capturée dans nos filets, mais en très faible nombre. En effet, c'est le crabe le plus commun de tout le littoral Tunisien (Com.per, 2009). Son caractère de refuge sous les pierres et entre les algues [3], explique peut être sa timide apparition et sa faible abondance.

Eucrate crenata (De Haan, 1835); Ce crabe de mer Rouge est présent dans les eaux tunisiennes depuis près d'une quinzaine d'années. Observé en premier dans le golfe de Gab ès (Zaouali, 1992), il est aujourd'hui, présent sur l'ensemble des côtes tunisiennes. Sa présence et son abondance mettent bien en évidence l'influence du réchauffement climatique global sur les eaux côtières de cette partie sud de la Méditerranée [1]. Après l'avoir observé au niveau de la lagune de Tunis, le voila aujourd'hui présent au plus au nord des côtes tunisiennes, au niveau de la lagune de Bizerte. Cependant, et après une vérification de nos données sur les décapodes de la lagune de Bizerte, nous pouvant dire que cette espèce est présente dans la lagune de Bizerte, au moins depuis 2005 (Com.pers, 2009). Ainsi, son ré-observation en 2009 et (en Avril 2010) confirme son installation définitive dans la lagune de Bizerte et la persistance des conditions abiotique et biotiques au niveau de ce milieu lagunaire favorablesà son existence.

Xantho poressa (Olivii, 1792); Cette espèce de roche est très souvent confondue avec sa cousine *Xantho incisus* (Leach, 1814), espèce atlantique présente en méditerranée [3], recensée déjà en Tunisie, au niveau du golfe de Gabès (d'après Zaouali, anonyme).

Cependant, et d'après les témoignages des pêcheurs locaux, cette espèce ne leur pas habituelle et malgré que ses effectifs demeurent très inférieurs à ceux de *Carcinus aestuarii ou d'Ilia nucleus*, elle se manifeste régulièrement dans leurs filets.

Parthenope angulifrons (Latreille, 1825); Cette espèce méditerranéenne [3] n'a pas été mentionnée précédemment au niveau de la lagune de Bizerte (Com.pers, 2009). Ainsi, et d'après les témoignages des pêcheurs recueillis, les effectifs de cette espèce seraient considérables, si on se réfère à la manifestation de cette espèce dans leurs filets. D'autre part, l'année 2008 serait marquée par l'observation de cette espèce de crabe dans la lagune. Actuellement, il serait toujours présent, mais avec des abondances nettement moins inférieures qu'en 2008.

Ilia nucleus (Linnaeus, 1758); Ce petit crabe, à la forme de noix et aux pattes longues et fragiles, est connu dans la lagune de Bizerte de depuis une dizaine d'années. Cependant et d'après le témoignage des pêcheurs et des observations personnelles, ces effectifs ont pris de l'importance depuis le début des années 90e. Ainsi, on peut considéré que cette espèce de crabe, vient dans la deuxième position après *Carcinus aestuarii*, en terme d'abondance. Cependant, cette espèce se trouve à des profondeurs plus importantes (généralement au delà de 5-6m) que celles caractérisent le crabe vert.

Maja squinado (Herbst, 1788); Cette espèce est l'une des espèces caractéristiques de la lagune de Bizerte et sa présence date depuis longtemps, malgré ces effectifs limités par rapports aux autres espèces ; En effet, l'espèce *Maja squinado* a une ex igence via à vis de son milieu puisqu'elle se trouve préférentiellement au niveau des substrats rocheux et difficiles d'accès, avec un net comportement de camouflage (couverture d'algues) [3], à la différence des autres espèces moins exigeants vis -à-vis du substrats et se trouvant dans la majorité des biotopes qu'offre cette lagune. La possiblité de présence de *Maja crispata* (Risso,1827) n 'est pas exclue (Com.pers, 2009).

Pachygrapsus marmoratus (Fabricius, 1787); Cette espèce a été péchée au niveau du canal de Bizerte, ainsi que le goule t qui connecte le canal à la lagune. Cependant, et malgré qu'aucun spécimen n'a été pêché au niveau de la lagune, sa présence lagunaire reste très possible. En effet, ce crabe de roche de la famille des Grapdidae se caractérise es par manifestations s nocturnes et son absence pendant le jour. Ainsi, quelques pêcheurs visant ce crabe l'appâtent et l'attirent durant la nuit moyennant une source de lumière (torche, lampe à pétrole, etc...). D'autre part, le confinement de cette espèce dans les zones rocheuses explique peut être son absence durant nos compagnes de prospection.

References

1 - **FAO. 1987.** Fiches FAO d'identification des espèces pour les besoins de la pêche-Zone de pêche 37 : Méditerranée et en Mer Noire. Chapitre V rai Crabes par L.B Holthuis. FAO, Rome.Vol.1: 322-3 69 p

2 - **FOREST J., GUINOT D. 1956.** Sur une Collection de Crustacés Décapodes et Stomapodes des mers tunisiennes. Bulletin Station Océanographique Salammbô, n° 53, Mars 1956 : 21-43

3 - **ZAOUALI J.1992.** Présence d'*Eucrate crenata* dans le golfe de Gabès (Crustacea, Decapoda, Brachyura) First reported occurrence of *Eucrate crenata* in the Gulf of Gabes, Tunisia (Crustacea, Decapoda, Brachyura). Marine Life, 1992, vol.2, n°1 : 53-56

HYDROCHEMICAL SPECIFICS OF THE KAMCHIA RIVER MOUTH AND THE ADJACENT BLACK SEA COASTAL AREA

Galina Shtereva [1]*, Anton Krastev [1], Boryana Dzhurova [1] and Ognyana Hristova [1]
[1] Institute of Oceanology - BAS, Varna, Bulgaria - g.shtereva@io-bas.bg

Abstract
The aim of the study is assessment of water quality (WQ) of the biggest Black Sea River (Kamchia River) and coastal waters on the base of chemical parameters. The results reveal that the nutrients content in river and mixing zone do not correspond to the Bulgarian WQ Standards. The transformed river waters are characterized with high nutrients concentrations and low salinity, pH and transparency.
Keywords: Black Sea, River Input, Nutrients, Metals, Oxygen

According to conceptual framework DPSIR (Driving forces –Pressure –State – Impact -Response) the main drivers (industry, agriculture and urbanization) in Kamchia River region (catchment and coastal zone) cause a significant pressure on the aquatic systems. The river collects urban effluents of many settlements in the catchment area, including untreated sewage discharges. The state of the river environment under long-term pressure/impact was already presented [1, 2]. The aim of the study is assessment of water quality of Kamchia River and coastal waters on the base of chemical parameters.

The study is based on monthly monitoring in Kamchia River during the 2006-2007 period of following parameters: pH, dissolved oxygen (DO), biochemical oxygen demand (BOD_5), nutrients as dissolved phosphorus (P), nitrogen (N), silica (Si) and metals. The investigation of water column in the coastal zone in front of the river mouth was carried out on the same parameters including salinity, transparency and metals in addition during the high flow period.

Long-term data of NIMH reveals monthly river discharge variability from 10.5 % to 17 % of annual discharge during the high flow period from January to May. In contrast to the historical data the recent period is characterized with similar mean monthly values of water quantity of discharge. An increase of the river discharge in autumn was established in relation to increased precipitation totals in Kamchia watershed. Average nutrients concentrations in the river for the investigated period are presented in Fig. 1.

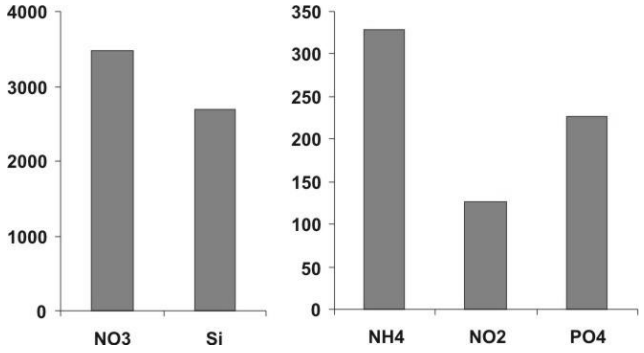


Fig. 1. Average nutrients concentrations in Kamchia River

The interannual distribution of hydrochemical parameters is characterized with maximums of nutrients content in Autumn-Winter period corresponding to high values of precipitations and high value of water quantity of the river discharge.

Sometimes our results reveal "poor" and "bad" status relative to National classification system for WQ. It means that there is a distinct pollution by nitrogen compounds largely due to agricultural activities and runoff from soil pollution. Deviation from normal distribution of nutrients content during some periods was established in consequence of anthropogenic pressure domination along the river stream. The factors, which influenced the nutrients content in the river at the downstream locality, is more numerous and complex. The results for the river WQ show that the nutrient content exceeds the permissible concentration (PC) maximum determined by the Bulgarian WQ Standards.

The river discharge directly influences the coastal waters near the mouth [3, 4]. Dissolved oxygen (saturation) is very important quality parameter indicating "health" of water environment. The data for coastal zone influenced by the river discharge reveal decrease of DO and OS, especially in bottom layer. The mixing zone of coastal area is characterized by salinity<7.9‰, pH<8.22 and very low transparency (Table 1).

Tab. 1. Range of chemical parameters in coastal area in front of Kamchia River mouth

Parameters	Mixing zone	Sea
Transparency, m	0.5–1.0	2.0–3.0
Salinity, ‰	0.9–7.9	10.4–14.3
pH	7.89–8.22	8.35–8.41
Dissolved oxygen (DO),µM/l	246–283	306–323
Oxygen saturation (OS), %	84.2–102.7	109.6–117.8
BOD_5	2.04-3.31	2.50-2.88
Nitite N, µM/l	2.2–5.7	0.6–1.2
Nitrate N, µM/l	27–154	16–22.4
Ammonia N, µM/l	3.4–5.6	1.6–2.7
PO_4-P, µM/l	1.6-3.2	0.1-0.2
Total P, µM/l	2.1–3.7	0.5–1.4
Si, µM/l	58-127	5-41
Ca^{2+}, mg/l	84.7-144.6	204-219
Mg^{2+}, mg/l	33.4-208.7	340-510
Fe, µg/l	190-413	43-92

Nutrients distribution in mixing zone reveals high nitrates and nitrites content exceeding PC [5]. The average concentration of DIN for all sampled area is 64.2 µM/l with maximum reached in coastal waters -165 µM/l. Relatively higher content of metals Fe and Mn are found in samples collected in and near river mouth. Heavy metals concentrations in waters of coastal zone correspond to WQ standards according Regulation 8 [5].

The sediments with dominated coarse-grained fraction are characterized with low organic carbon content and low concentrations of metals. They are located near the river mouth, where the sedimentation is more active due to the sudden changes in hydrological conditions. The concentrations of metals in surface sediments are characterized by the following order of spreading: Fe>Mn>Zn>Pb,Cu>Ni>Cd.

The Kamchia River discharge impacts the coastal zone in an area located less 1 mile eastward and southward from the river mouth. Most significant influence is found in the upper surface layer which is characterized by higher nutrients and particulate material content and lower transparency, pH and salinity.

Acknowledgements: The study was supported by National Scientific Fund (Research project No 1504/2005).

References
1 - Shtereva, G., O. Hristova., 2006. Nutrients in Water of Kamchia River, Bulgaria, *J. of Balkan Ecology*, Vol. 9, 2, 183–189.

2 - Shtereva, G., B. Dzhurova, A. Krastev, O. Hristova., 2006. Impact of Kamchia River discharge on the coastal zone water quality, *Proceeding of 1-st Black Sea Conference*, "Black Sea Ecosystem 2005 and Beyond" May 2006, Istanbul, pp.45-52.

3 - Shtereva, G., B. Dzhurova., 2006. Nutrients distribution in coastal waters impacted of river discharge. *Proceedings of SU, V. 1/2006*, 107-112. (in Bulgarian).

4 - Shtereva, G., B. Dhurova, O. Hristova, A. Krastev., 2007. Interactions between Kamchia River and coastal waters (Bulgarian Black Sea). 38 CIESM Congress, 9-13 April, 2007, Istanbul, Turkey, p. 703.

5 - Regulation ? 8 for water quality of coastal waters., 2001, Ministry of Environment and waters.

EFFECTS OF THE RECENT CLIMATE CHANGES TO THE WATER BUDGET OF A SEMI-ENCLOSED GULF IN EASTERN MEDITERRANEAN

Alexandra Spyropoulou [1] and George Tsirtsis [2]*
[1] Dept. of Marine Sciences, Univ. of the Aegean, Greece, spyropoulou@marine.aegean.gr
[2] Dept. of Marine Sciences, Univ. of the Aegean, Greece - gtsir@aegean.gr

Abstract
An analysis of available rainfall data for the period 1955-2008 was performed to assess changes in rainfall frequency and intensity in an Aegean island, Eastern Mediterranean. A statistically significant decrease was observed for the annual rainfall height and the number of wet days, whereas no trend was observed for the occurrence of extreme events. The effects of the changes in precipitation for the functioning of a semi-enclosed gulf were then assessed using a watershed model and a water budget analysis.
Keywords: Aegean Sea, Coastal Systems, Global Change, Eastern Mediterranean

The recent climate changes probably constitute the main environmental concern facing mankind in the twenty first century [1]. The effects of changes in precipitation on the functioning of coastal systems, are probably more pronounced for small Eastern Mediterranean watersheds and the receiving water bodies that undergo rapid hydrological cycles characterized by a rather short rainfall period during winter and a dry summer.

In the present work, a time series of rainfall data (provided by the Hellenic National Meteorological Service, HNMS) were analyzed covering the period from 1955 to 2008 for the island of Lesvos, in the North-eastern Aegean and a large number of climatological indices was calculated [2] to assess local trends in precipitation. The effects of possible changes on the functioning of the Gulf of Kalloni, a semi-enclosed shallow water body surrounded by a watershed of about 413 Km^2 [3], were then analyzed using a watershed model and applying water budget analysis.

A statistically significant decrease (R^2=0.1022, p=0.018) was observed for annual rainfall height (Figure 1) and the number of wet days (R^2=0.1384, p=0.006) from 1955 to 2008, whereas the frequency and intensity of extreme events has shown no trend. Overall a significant trend towards dry conditions was sought for the study site, especially during the winter period.

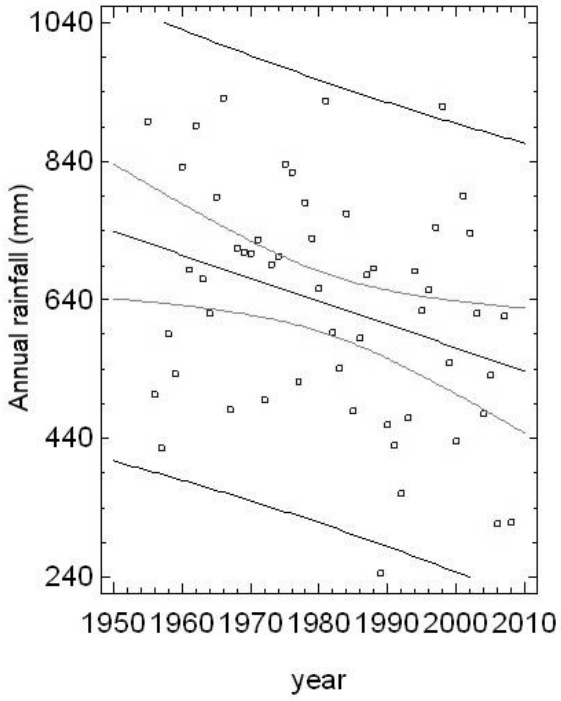


Fig. 1. Trend of annual rainfall height from 1955 to 2008.

Typical years of wet (year 1961) and dry (year 2005) conditions were used as an input to a watershed model calculating the amount of runoff on a daily basis [4]. The model output and available data were then used to analyse the water budget of the receiving reservoir. A threefold decrease in the amount of runoff was predicted by the model (Figure 2) influencing remarkably the water budget of the gulf, although it is still functions as a dilution (during winter) and concentration (during summer) basin. However the excess of the sum of precipitation and river input over evaporation during winter has almost halved during the last decade since the decade of 1960, resulting to a remarkable decrease in the water renewal time in winter being 86 days for 1961 and 50 days for 2005.

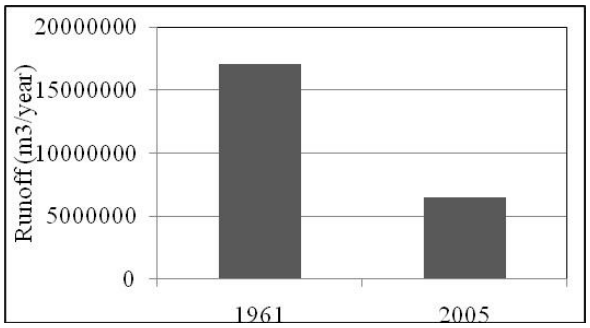


Fig. 2. Annual runoff for a typical wet (1961) and a dry (2005) year.

In conclusion a trend towards dry conditions is observed in the islands of Northern Aegean in Eastern Mediterranean affecting the water budgets of both the river basins and the receiving water bodies. These changes need to be always taken into account by policy makers in the framework of integrated coastal zone management.

References

1 - Brunneti M., Maugeri M., Nanni T. and Navarra A., 2001. Droughts and extreme events in regional daily Italian precipitation series. *Int. J. Climatol.*, 22: 543–558.

2 - Kostopoulou E. and Jones P.D., 2005. Assessment of climate extremes in the Eastern Mediterranean. *Meteorol Atmos Phys*, 89: 69–85.

3 - Spatharis S., Danielidis D.B. and Tsirtsis G., 2007. Recurrent *Pseudo-nitzschia calliantha* (Bacillariophyceae) and *Alexandrium insuetum* (Dinophyceae) winter blooms induced by agricultural runoff. *Harmful Algae*, 6: 811-822.

4 - Arhonditsis G., Tsirtsis G. and Karydis M., 2002. The effects of episodic rainfall events to the dynamics of coastal marine ecosystems: applications to a semi-enclosed gulf in the Mediterranean Sea. *Journal of Marine Systems*, 35: 183-205.

THE EFFECTS OF A WASTEWATER TREATMENT PLANT ON NUTRIENT AND CHLOROPHYLL A VARIATIONS IN IZMIR BAY (EASTERN AEGEAN SEA)

Fatma Sanem Sunlu [1]*, Ugur Sunlu [1], Baha Buyukisik [1] and Serkan Kukrer [1]
[1] Ege University Faculty of Fisheries Dept. of Hydrobiology - f.sanem.sunlu@ege.edu.tr

Abstract
The aim of this study was to determine the effects of the Izmir Big Channel Waste Water treatment plant oninorganic nutrients, physico-chemical parameters, (such as pH, dissolved oxygen, water temperature, salinity) and chlorophyll a levels of Izmir Bay. The variation of inorganic nutrients and chlorophyll a were investigated weekly during one year (2003-2004) in Izmir Bay.
Keywords: Aegean Sea, Nutrients, Chlorophyll-a, Coastal Waters, Pollution

Introduction
The Bay of Izmir is located in the Western part of Turkey and surrounded by a densely populated community (Fig. 1). The Bay is divided into inner, middle and outer bays from the standpoint of topographical and hydrographical characteristics. The inner bay is considerably small in area (57 km2) and shallow in depth (max. 15 m). It received the majority of domestic and industrial wastewaters before the construction of wastewater treatment plants. This part of the bay still receives some inflow of freshwater from several creeks which are mostly polluted by industrial wastewaters. Because of limited water exchange with the outer bay and the Aegean Sea, pollution of the inner bay reached unacceptable levels. For this reason, the Izmir Municipality decided to construct the Izmir Big Channel Wastewater Project in 1969. Unfortunately, the construction of the plant could not be completed until the end of 2002. At the end of the plant construction in 2002, the pollutant levels of the inner bay water decreased gradually and the recovery period began. The aim of this study is to determine the effects of Izmir Big Channel Waste Water treatment Plant to the inorganic nutrients and chlorophyll a levels of Izmir Bay.

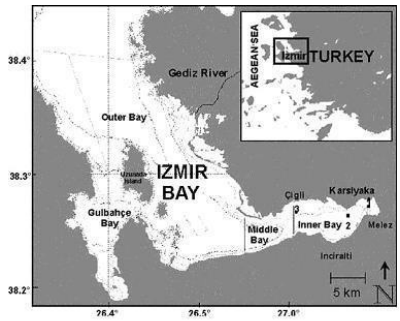


Fig. 1. Locations of the stations

Materials AND Methods
In this study, three stations were chosen for sampling, two in the inner and one in the middle part of the Izmir Bay (Figure 1). Physico-chemical parameters, nutrients, and some biological parameters were measured weekly during a one-year period. The samples, collected from three different stations and water depths, and nutrients were analyzed by standard methods ([1], [2], [3]). Chlorophyll a analyses, were carried using a UVD spectrophotometer (Bosch-Lomb Spectronic 21) following the method by [1]. Seawater temperature was recorded by an electronic thermometer with a sensitivity of ±0.1 °C. The pH of the samples was also measured on-site using a pH-meter (Hanna Ins.). The dissolved oxygen (DO) was measured with a DO-meter (YSI, Model 55). The salinity of seawater was determined by the Harvey method.

Results and Discussion
The minimum, maximum and average values of the physico-chemical parameters belonging to the water samples from Izmir Bay are given in Table 1.The fact that the processes affecting Reactive Phosphate (RP) and TIN occur at different times indicates important differentiations in the temporal distribution of these two nutrients in the Inner Bay. From the distribution of the nutrients and their percentages, important evidence regarding the process have been gathered: a) Inflow with the creeks is especially evident during rainfall and there is a big increase in Si, Nitrogen forms; and b) the winds, although increasing fresh water inflow and water columns, frequently carry the ground water to the surface. This shows that the Inner Bay is often subject to a ground-water-based nutrient enrichment. c) The phytoplankton blooms caused by the inflow of nutrients to the Inner Bay in turn result in the uptake of nutrients by the phytoplankton (especially diatoms) which are then exported to the bottom waters and constitute the source for future phytoplankton blooms.

Tab. 1. Ranges and mean (± s.e.) values of physico-chemical parameters

	Station 1		Station 2		Station 3	
	Range	Mean±SE	Range	Mean±SE	Range	Mean±SE
Temperature	9.0-28.2	18.68±0.5	8.9-27.4	18.56±0.42	9.6-28.0	18.90±0.37
Salinity	31.93-43.85	39.84±0.13	33.97-43.85	39.98±0.11	33.97-44.85	39.9±0.1
pH	7.4-8.6	8.03±0.01	7.5-8.7	8.08±0.01	7.5-8.6	8.09±0.01
DO	3.86-14.40	7.44±0.14	4.57-13.60	7.72±0.12	4.16-12.9	7.72±0.09
NH_4-N	0.21-36.97	7.83±0.56	0.00-32.19	4.89±0.30	0.09-40.94	3.84±0.29
NO_3-N	0.00-19.31	4.55±0.38	0.00-21.35	3.50±0.26	0.00-17.63	2.10±0.16
NO_2-N	0.00-28.99	3.54±0.38	0.00-16.99	2.54±0.24	0.00-9.69	1.06±0.10
PO_4-P	0.60-16.05	3.67±0.16	0.54-19.56	3.51±0.18	0.00-31.43	2.77±0.21
Si	0.31-43.89	12.62±0.77	0.47-54.12	11.47±0.64	0.16-41.80	8.81±0.54
N/P	0.57-15.69	5.43±0.29	0.23-20.52	4.46±0.26	0.00-53.65	4.36±0.40
Si/P	0.22-28.03	4.31±0.35	0.27-56.38	4.56±0.40	0.00-83.38	5.60±0.61
Chl a	0.00-66.13	5.72±0.59	0.00-23.55	4.65±0.28	0.00-12.82	2.78±0.17

Thus, the horizontal export of the nutrients out of the Inner Bay remains limited. It is only due to the winds that the wastewaters flow outwards from time to time. Silicate, coming with the rainfall from the shore in non-point sources (i.e. creek, river) and point sources, is of great importance for the Inner Bay. Silicate is essential for the diatoms to compete effectively with dinoflagellates and it plays an important role in the increase in species diversity in the bay. We believe that unless the nutrient levels in the rivers are decreased, the Bay will continue its current state for a long time. Although a decrease in nitrogen has been observed after the start of the wastewater treatment plant, former studies showed that phosphate concentrations have not changed and that the plant has been ineffective regarding this subject.([4], [5],[6],[7]). The effective removal of phosphate will be an important precaution against the new strategy that the phytoplankton might take up against the decreasing TIN. A study of the N/P relations shows that for the biggest part of the year the ratio is below 16 and that nitrogen is the limiting nutrient. As a result, with the start of the wastewater treatment plant a decrease in the nitrogen and chlorophyll-a levels has been found, however there is no such evidence regarding the phosphate levels.

References
1 - Strickland, J.D.M., T.R Parsons. 1972 . A practical handbook of sea water analysis bulletin 167 , Fisheries Res. Board Of Canada , Ottowa.:310
2 - Wood, R.D , 1975. Hydrobotanical methods. University Of Park Pres , London:173.
3 - T. R. Parsons, Y. Maita, M. Lalli., A Manual of Chemical and Biological Methods for Sea Water Analysis, Pergamon Press, New York, 1984
4 - Kontas, A., Kucuksezgin, F., Altay, O. and Uluturhan, E.,2004, Monitoring of eutrophication and nutrient limitation in the Izmir Bay (Turkey) before and after wastewater treatment plant, *Environmental International* 29, 1057-1062 p.
5 - Kukrer, S., Aydin, H., 2006, Investigation of temporal changes of phytoplankton in Karsiyaka Yacht Port (Izmir Inner Bay), EU. Journal of Fisheries and Aquatic Science. Vol 23 No (1-2) : 139-144 p. (In Turkish)

A PRELIMINARY STUDY ON MARINE LITTER IN THE AEGEAN SEA

Eda N. Topcu [1]*, Arda M. Tonay [1] and Bayram Öztürk [1]
[1] Istanbul University Fisheries Faculty Ordu cad. No 200 Laleli-Istanbul, Turkey / Turkish Marine Research Foundation (TUDAV)
P.O.Box: 10 Beykoz-Istanbul, Turkey - edatopcu@istanbul.edu.tr

Abstract
Solid Marine Wastes present on the seabed and floating on the sea surface were investigated in the Aegean Sea. Compared to other locations in the Mediterranean, litter concentration on Northern to Mid Aegean Seabed is moderate even in populated gulfs, whereas floating marine debris concentrations are low and dominated by recreational items, probably restricted to summer season.
Keywords: Aegean Sea, Plastics, Pollution

Solid waste materials (SMW) in the marine environment have become an important pollution issue with impacts on marine life and negative economic impacts. Only one study on litter has been conducted in the Aegean Sea [1]. The Aegean has, isince 1st May 2009, the status of "Special Area" under Regulation 5 of Annex V (MARPOL) which prohibits any discharges of garbage in sea. Regarding land-based pollution, the Barcelona Convention and its relevant protocol is the most effective international instrument.

SMW present on Northern to Mid Aegean Seabed were investigated in August, October and December 2008 (Fig. 1). Litter items were collected by trawling in depths ranging from 65 m to 880 m. Litter items caught in nets were collected, dried, separated, counted and weighted. The swept area method was applied for the calculation of the amount of litter on seabed. Floating Marine Debris (FMD) sightings were also recorded during August 2008 cruise by an observer with a handheld GPS and binoculars. The strip transect method (width=60m; length= distance of legs in km) was used in order to determine the abundance of FMD.

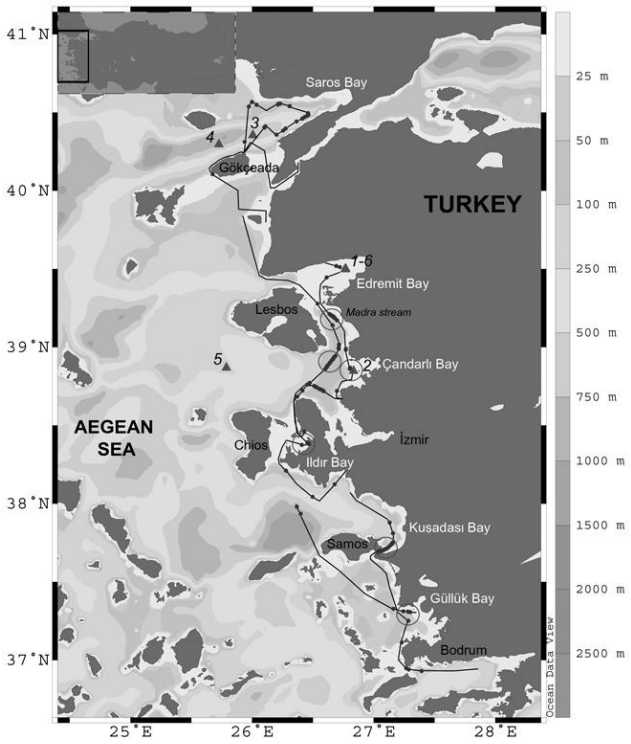


Fig. 1. Map of the study area. Small circles = FMD observations (n= 140). Triangles = trawling stations (1-6). Large circles = FMD tufts.

FMD were observed mainly in areas close to land (1,75–3,52 items/km^2) whereas offshore areas were generally clean of litter (0–0,18 items/km^2). However we should specify that one of the offshore transects was run under poor weather conditions. There is a significant correlation between the number of items and distance from land (r_s=-0,86). FMD were widespread in gulfs and some places seemed particularly concentrating litter items causing tufts of litter (Fig. 1). The highest abundances were found in the Dikili Strait located between Lesbos (Midilli) Island and Madra Stream-Altinova.

Accordingly bottom ML were mainly abundant in gulf areas (299,98-211,75 items/km^2; 27,6-2,85 kg/km^2) whereas the abundance of SMW was very low (48 items/km^2 and 2,26 kg/km^2) in the open sea location between Lesbos and Chios (Sakiz) Islands. Litter pollution in gulfs is significant and similar to other sites in the world but lower than other locations in the Aegean Sea [1] and Black Sea [2]. SMW pollution is not very high compared to the value of 1935 ± 633 Items/km^2 which is estimated for the NW Mediterranean [3].
The highest values of FMD reported in this study are considerably low compared to other locations in the Mediterranean (2000 items/km^2, [4]; 1,5-25 items/km^2, [5]) and in the world (1-250 items/km^2, [6]). It is interesting to find such low values for the Aegean Sea which is an enclosed sea within the Mediterranean and an area of recreation and fisheries. ML tufts observed in gulfs make 1/3 of all litter items and could be the result of convergence zones of wind induced Langmuir cells. This natural collection system could facilitate the removal of ML in high season when FMD values arise.
Plastics were the dominant material type among both bottom (84,13%) and surface (75%) SMW. Most of litter items on seabed were nylon bags and wrappings whereas FMDs consisted of recreational items such as plastic sea beds and sea balls, followed by plastic bags, PET bottles and food wrappings. The recreational origin of most FMD items indicates a probable restriction to the summer season. Litter items seem to have mainly land-based origin considering their types and usage categories. Other litter sources could be fish farms (items such as fish feed bags and sacks were found) and pleasure boats. Only 5 items had labels readable on and 2 of them were overseas garbage.

This study reports low to moderate levels of bottom and floating ML pollution for some locations in the Aegean Sea. Although this result is promising, the limited number of stations and transects of this preliminary study does not allow to make a general conclusion on Aegean Sea ML pollution. More studies and monitoring programs are necessary in order to estimate pollution levels and develop appropriate mitigating solutions in the Aegean Sea.

Support from East-Med Turkey project fund of I.U. Fisheries Faculty and field assistance of R/V Yunus-S Crew and Tughan Turan is acknowledged.

References
1 - A. Katsanevakis and A. Katsarou, 2004. Influences on the distribution of marine litter on the seafloor of shallow coastal areas in Greece (Eastern Mediterranean). *Water, Air, Soil Pollut.*, 159: 325-337.
2 - Topçu N.E. and Öztürk B., 2008. Marine Litter in The Black Sea as a Growing Problem. 2nd Biannual and Black Sea SCENE EC Project Joint Conference, 6-9 October, Sofia, Bulgaria, pp: 277-283.
3 - Galgani, F., Jaunet, S., Campillo, A., Guenegen, X. and His, E., 1995. Distribution and abundance of litter on the continental shelf of the North western Mediterranean Sea. *Mar. Pollut. Bull.*, 30: 713-714.
4 - Morris R.J., 1980. Floating plastic debris in the Mediterranean. *Mar. Pollut. Bull.*, 11, 125.
5 - Aliani S., Griffa A. and Molcard A., 2003. Floating debris in the Ligurian Sea, north-western Mediterranean. *Mar. Pollut. Bull.*, 46: 1142-1149.
6 - Hinojosa I.A. and Thiel M., 2009. Floating Marine Debris in fjords, gulfs and channels of Southern Chile. *Mar. Pollut. Bull.*, 58: 341-350.
7 - Schlitzer, R., Ocean Data View, http://odv.awi.de, 2009.

ARE HIGHER TAXA ADEQUATE SURROGATES FOR SPECIES LEVEL RICHNESS IN MARINE BENTHIC MOLLUSC COMMUNITIES?

Irini Tsikopoulou [1]*, Chryssanthi Antoniadou [1], Eleni Voultsiadou [1] and Chariton Chintiroglou [1]
[1] Department of Zoology, School of Biology, Aristotle University of Thessaloniki - etsikopo@bio.auth.gr

Abstract
The higher-taxa richness as a surrogate of species richness in macrobenthic mollusc communities was explored in Thermaikos Gulf, north Aegean. Statistical analysis showed significant correlation between richness at the species level and richness at the genus as well as the family level. In addition, an increase in correlation values over the years of study was observed, implying an increase of anthropogenic impact in the area.
Keywords: Aegean Sea, Biodiversity, Bivalves, Gastropods, Mollusca

Introduction
Species richness is considered as the most appropriate measure to assess biodiversity in a specific area [1]. However, in many cases the use of higher-taxa levels as surrogates for the species level can produce a reliable faunal distribution pattern provided that there is a strong correlation between species richness and genus and/or family richness [2]. Such an approach has the advantages of being expense-reducing and time saving for biomonitoring studies ([3], [4]). The present study examines the genera and families levels of gastropod and bivalve molluscs for their suitability as surrogates of species level in abundance and species richness assessment of macrobenthic molluscan communities, in Thermaikos Gulf, north Aegean.

Materials and methods
Sampling was carried out for three successive years (summer 2001 - winter 2004). Three vertical transects along the NE coasts of Thermaikos Gulf were selected in the area around the construction site of the new air corridor of Thessaloniki Airport. Six stations - two on each transect were sampled for benthic macrofauna with corer samplers at depths between 3 and 10 m. The Spearman rank correlation coefficient was used to determine whether there was a statistically significant correlation (r_s values) between richness at different taxonomic levels.

Results and discussion
In total, 6931 gastropods were collected belonging to 62 species and 920 bivalves belonging to 39 species. Genus and family levels provided adequate surrogates, for gastropod and bivalve species richness, in the three annual samplings (Figure 1). The correlation between species and family richness was lower (r_s=0.81) in the first sampling period (2001) than in the other two periods (2002, 2003). These results are in accordance with those of Chintiroglou et al. ([5]) for the same area concerning the mollusc fauna as a whole. In areas where anthropogenic impact is extensive, higher taxa are represented by a small number of species and their use as surrogates of species richness is more reliable than in non-disturbed areas ([1],[6]). In the study area an increased anthropogenic perturbation has been recorded over the years ([7]).

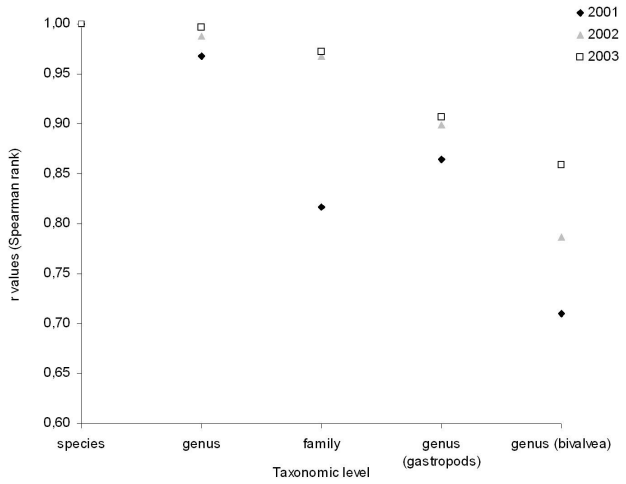


Fig. 1. Degree of correlation between richness for the species level and richness for higher taxonomic levels of molluscs as well as for gastropods and bivalves separately in the three sampling periods

References
1 - Olsfrad F., Somerfield P.J., and Carr M.R., 1998. Relationships between taxonomic resolution, macrobenthic community patterns and disturbance. *Mar. Ecol. Prog. Ser*., 172: 25-36.
2 - Williams P.H. and Gaston K.J., 1994. Measuring more of biodiversity: can higher-taxon richness predict wholesale species richness? *Biol. Conserv*., 67: 211-217.
3 - Balmford A., Green M.J.B. and Murray M.G., 1996. Using higher-taxon richness as a surrogate for species richness. I. Regional tests. *Proceedings of the Royal Society of London*, 263: 1267-1274.
4 - Gaston K.J., 2000. Biodiversity: higher taxon richness. *Progr. Phys. Geo.*, 24: 117–127.
5 - Chintiroglou C.C., Antoniadou Ch., Damianidis P. & E. Kourelea., 2007. Surrogate measures of biodiversity in macrobenthic communities in Thermaikos Gulf, Greece. Rapp. Comm. int. Mer Médit., 38, 449.
6 - Olsgard F. and Somerfield P. J., 2000. Surrogates in marine benthic investigations - which taxonomic unit to target? J. Aquat. Ecos. Stress Recov., 7: 25-42
7 - Antoniadou C., Krestenitis Y. and Chintiroglou C., 2004. Structure of the "amphioxus sand" community in Thermaikos bay (Eastern Mediterranean). *Fresen. Environ. Bull.*, 13: 1122-1128.

MERCURY LEVELS IN SEDIMENTS FROM GREEK COASTAL AREAS

Eleni Tzempelikou [1]*, Fotini Botsou [1], Manos Dassenakis [1] and Michael Scoullos [1]
[1] NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS - etzempelikou@gmail.com

Abstract
This study examines total mercury levels in coastal and lagoon surface sediments (n= 55) from the Aegean and Ionian Sea. The results obtained were compared to bibliographic data from the Greek marine environment and spatial and temporal trends were evaluated.
Keywords: Mercury, Sediments, Aegean Sea, Ionian Sea

Introduction

Mercury is one the most toxic pollutants in the environment and in the last years several policies for the limitation of the use of this metal are coming into force. Thus, continuing monitoring studies can prove a useful tool in order to evaluate such initiatives. The aim of this study was to: a) determine Hg levels in sediments from 5 regions in the Aegean and Ionian Sea, b) compare these data to previously reported ones and obtain an overview of mercury distribution along the Greek coasts and c) identify main sources of pollution.

Study areas

The study areas of our research were the coastal areas of Western Saronikos Gulf (area 1a), Larymna Bay (area 2) and Maliakos Gulf (area 3) at the central Aegean Sea and two lagoons of the Corfu Island, Antinioti (area 17) and Korission lagoon (area 18) at the northern Ionian Sea (Fig. 1).

Results and discussion

Total Hg in sediments was determined with microwave assisted-extraction with HNO_3 followed by CVAAS analysis [1]. In the Aegean Sea, the concentrations determined ranged from 0.06 to 0.32 μg/g in the Western Saronikos Gulf, 0.14 - 0.54 μg/g in Larymna Bay and 0.12 - 0.34 μg/g in Maliakos Gulf. The higher concentrations were found at areas impacted from industrial activities, and more specifically in the vicinity of a crude oil refinery (Saronikos Gulf) and a ferro-nickel smelting plant (Larymna Bay). Higher levels (0.48 - 3.89 μg/g) were determined in lagoon sediments from the Ionian Sea. We believe that mercury in the two lagoons of the Corfu Island may have a natural origin, since no intense sources of pollution are recognized in these areas. Currently, additional research is conducted by our team, in order to determine sources and forms of mercury in surface and subsurface sediments.

Tab. 1. Total mercury content in Greek coastal areas in μg/g dry weight

Area	Area code	Hg_T (μg/g)	Reference
Western Saronikos Gulf	1a	0.06-0.32	Present study
		0.18-0.23	2
Elefsis Gulf	1b	0.10-0.51	2
Larymna Bay	2	0.14-0.54	Present study
		0.12	4
Maliakos Gulf	3	0.12-0.34	Present study
Pagasitikos Gulf	4	0.02-0.18	2
Thessaloniki Gulf	5	2.90-8.88	5
Axios River	6	0.21-0.31	6
Strymonikos River	7	0.07-0.46	2
Stratoni	8	0.53	2
Kavala Gulf	9	2.95-5.25	5
Nestos River	10	0.06-0.29	2
Evros River	11	0.32	2
Aegean Sea	12	0.10-0.25	2
Korinthiakos Gulf	13	0.03-0.07	2
Argolikos Gulf	14	0.03-0.08	2
Crete Island	15	<0.01-0.06	2
Ionian Sea	16	0.11-0.30	7
Antinioti Lagoon	17	0.67-3.89	Present study
Korission Lagoon	18	0.48-1.39	Present study
Patraikos Gulf	19	<0.10-1.36	2
		0.36-0.71	7

The results of our study were compared with previously published data from other Greek coastal areas [2] - [6]. Some of these data are presented in Table 1; Figure 1 shows the locations of the areas. Elevated mercury levels were found in sediments of the Gulf of Thessaloniki (area 5) and Gulf of Kavala (area 9) in the northern Aegean Sea. These levels were attributed to industrial and municipal wastewaters. Sediments from Elefsis Gulf (area 1b) in Saronikos Gulf, Patraikos Gulf (area 19) in central Greece and Stratoni (area 8) in the northern Greece were moderately enriched in Hg and were comparable to the estuarine sediments of the transboundary Rivers of Strymonikos (area 7), Nestos (area 10), Axios (area 6) and Evros (area 11) in the northern Aegean Sea. The lower levels were found in the coasts of Crete Island (area 15), Korinthiakos (area 13), Argolikos (area 14) and Pagasitikos Gulf (area 4). As far as it concerns temporal trends, in two occasions, Western Saronikos Gulf and Larymna Bay, an increase over time has been observed.



Fig. 1. Locations of the examined areas.

Summarizing the above results, the higher levels of mercury were found close to industrial sites and harbors, while urban runoff was recognized as a secondary source. Thus, we can conclude that mercury contamination in Greek coastal areas is mostly related to fossil fuel combustion and crude oil leakages from ships and washing from the urbanized sites.

References

1 - Bettiol C., 2008. Evaluation of microwave-assisted acid extraction procedures for the determination of metal content and potential bioavailability in sediments. *Applied Geochemistry*, 23: 1140–1151.
2 - Laboratory Network for the Environmental Quality Monitoring of the Hellenic Seas. Athens, September 2006.
3 - Tserepa Ch., 1998. Methods for the determination of mercury in environmental samples. Master Thesis, Dept. of Chemistry, University of Athens (in Greek).
4 - Fytianos K. and Vasilikiotis G., 1983. Concentrations of heavy metals in sea water and sediments from the Northern Aegean Sea, Greece. *Chemosphere*, 2: 83–91.
5 - Zachariadis G.A., 1991. Determinations of forms of mercury by cold vapor atomic absorption spectrometry and optimization by factorial design. PhD Thesis, Dept. of Chemistry, Aristotle University of Thessaloniki.
6 - Leotsinidis M. and Sazakli E., 2008. Evaluating contamination of dredges and disposal criteria in Greek coastal areas. *Chemosphere*, 72: 811–818.

FACING GLOBAL WARMING IN TRANSITIONAL AREAS: CHARACTERIZATION OF VARIABILITY IN SIX MEDITERRANEAN LAGOONS BY MEANS OF NUMERICAL MODELING

G. Umgiesser [1], C. Ferrarin [1], A. Cucco [2], A. Perez ruzafa [3], F. De pascalis [1]*, M. Ghezzo [1], D. Bellafiore [1] and M. Bajo [1]
[1] ISMAR-CNR, Venice, Italy - francesca.depascalis@ve.ismar.cnr.it
[2] IAMC-CNR, Oristano, Italy
[3] Department of Ecology and Hydrology, University of Murcia

Abstract
The Global Warming strongly affects coastal areas and can deeply change the status of transitional areas like lagoons. Numerical modeling is presented as a tool to characterize lagoons and to quantify their rate of change. The SHYFEM model has been applied to six Mediterranean lagoons and a comparison study between the lagoons has been carried out. The lagoons are the Venice lagoon and the Marano-Grado lagoons in the Adriatic Sea, the Taranto basin in the Ionean Sea, The Cabras lagoon in Sardinia, the Mar Menor in Spain and the Nador lagoon in Morocco, giving a representative picture of the lagoons situated around the Mediterranean basin. The numerical study of each lagoon is the baseline from where the different responses to climate changes, in terms of temperature and salinity variation, are studied.
Keywords: Lagoons, Models, Coastal Systems, Global Change

Introduction
Lagoons are fragile systems in an unstable equilibrium due to their characteristics, in transition between land and sea. Abrupt changes in terms of increasing temperature and major water supply due to global warming and sea level rise, can strongly modify these environments, particularly for those around the Mediterranean Sea. Monitoring permits to study the variation of the lagoon characteristics from measurements. Numerical Modeling allows the investigation also of future scenarios. The application of a model in a number of lagoons around the Mediterranean Sea and the inter-comparison of the responses of the lagoons to different forcings, in terms of temperature and salinity variation, can help both for the general characterization of lagoons and for the future scenarios of global warming on the areas of transition.

Description of Sites
The lagoons we chose are located all around the Mediterranean, and are part of very different environments, interacting both with shallow coastal areas, like the Venice [1] and the Marano-Grado [2] lagoons in the North Adriatic, or deep seas, like Mar Menor [3] and the Nador lagoon [4]. The lagoons range from a leaky type of lagoons (Venice) to a choked type (as for the case of the Cabras lagoon [5]). The number of inlets ranges from just one in the Nador lagoon [4] to 6 in the case of the Marano-Grado lagoons. Lagoons normally communicate directly with the sea, but, in the case of Taranto, a semi-enclosed basin between the sea and the lagoon is present [6]. Tidal range is from micro-tidal to meso-tidal. The depth ranges from an average depth of 1 m to up to 6 meters.



Fig. 1. Location of the six Mediterranean lagoons studied.

All lagoons show strong impact of wind forcing. In most lagoons fresh water input is small, but it is relatively strong in the Marano-Grado case [2]. Wind and tidal stirring normally prevent the lagoons from developing stratification but less dynamic lagoons could show different vertical configurations. The exchange rate depends mainly on the inlet configuration, but also on the wind regimes in the case of multi-inlet lagoons. The exchange rate is also an important factor that can determine the residence time distribution inside the lagoons.

Methods
The model (SHYFEM) is a finite element model, especially suited to shallow water basins with complicated geometric and morphologic variations [1]. It solves the well known hydrodynamic equations with the semi-implicit algorithm on a flexible grid made of triangular elements. It has been applied in its 3D version in order to study the dynamics of lagoons introducing vertical variability and to properly describe the precipitation, evaporation and the river runoff effects in these areas. The model can compute the basic hydrodynamics, dispersion of tracers, temperature and salinity evolution, sediment transport and ecological parameters.

Results and Discussion
Temperature and salinity mean values and variability have been computed for the six lagoons, serving as the reference simulations. The A1B global change scenario has been applied to the lagoons, in terms of air temperature and evaporation increase, precipitation decrease, sea level rise and river runoff variation. In all lagoons higher residence times are registered, compared to the reference simulation, also caused by the major lagoon water volume, due to sea level rise. Lagoons become more saline partially due to the negative value of precipitation-evaporation. The 6 Mediterranean Lagoons have been classified using the division in choked, restricted and leaky. Leaky lagoons, as Marano-Grado Lagoons, are mainly governed by the exchange with the open sea and response to climate change is comparable with the open sea. On the other hand, chocked lagoons (Mar Menor) show more severe variations and experience the highest changes in temperature and salinity fields. Restricted lagoons show intermediate behaviour.These results are important also for other disciplines, like biology and ecology, to handle the global warming effects in transition areas.

References
1 - Umgiesser G., Melaku-Canu D., Cucco A. and C. Solidoro., 2004. A finite element model for the Venice Lagoon. Development, set-up, calibration and validation. *Journal of Marine Systems* 51: 123-145.
2 - Ferrarin C., Umgiesser G., Mattassi G., Scroccaro I.. Hydraulic zonation of the Lagoons of Marano and Grado, Italy. A modelling approach. Submitted to *Environmental Modelling & Software*.
3 - De Pascalis F., Perez Ruzafa A., Gilabert J., Umgiesser G., Marcos C.. Implementation of numerical model in the Mar Menor coastal lagoon (Spain). Submitted to *Ecological Modelling.*
4 - Umgiesser G., Chao J., Bajo M., Scroccaro I. and Cucco A., 2005. Residence time modeling in the Nador lagoon, Morocco. *Proceedings of ICCCM'05*.
5 - Ferrarin C. and Umgiesser G., 2005. Hydrodynamic modeling of a coastal lagoon: The Cabras lagoon in Sardinia, Italy. *Ecological Modelling*, 188, I 2-4: 340-357.
6 - Scroccaro I., Matarrese R., and Umgiesser, G., 2005. Application of a finite element model to the Taranto Sea. *Chemistry and Ecology*, 20, S1: 205-224.

UNDERSTANDING FLOWS OF ECOSYSTEM SERVICES: THE INTERCONNECTEDNESS OF TERRESTRIAL, COASTAL, AND MARINE SYSTEMS

F. Villa [1]*, S. Silvestri [2], M. Ceroni [1], M. Barcellos [2] and N. Barnard [2]
[1] Ecoinformatics Collaboratory, Gund Institute for Ecological Economics, University of Vermont - fvilla@uvm.edu
[2] UNEP World Conservation Monitoring Centre

Abstract

ARIES is a new methodology and web application meant to assess ecosystem services and illuminate their values to humans in order to make environmental decisions easier and more effective. In this contribution, we discuss the use of ARIES to understand how marine, coastal, and terrestrial ecosystems are linked in the provision of ecosystem services. We illustrate perspectives for integration of such thinking into coastal management and decision-making.

Keywords: Coastal Processes, Ecosystem services, Coastal Management

The benefits that our societies receive from ecosystems in the form of services such as water purification have a dynamic nature in that they are carried from source of origin to areas where they are used. Matter, energy or information serves as carriers that transmit the benefits through space and promote its transfer to humans. For example CO_2 is the vehicle for carbon sequestration and storage, floodwater for disturbance regulation, and scenic views for aesthetic value. Tracking the spatial flow of benefits can be help highlight the interconnectedness between terrestrial, coastal, and marine ecosystems, providing decision-makers and managers a way to assess the propagation of potential impacts and the opportunity of protecting or enhancing existing functions. ARIES (ARtificial Intelligence for Ecosystem Services) is a new methodology and web application (Villa et al., 2009) meant to assess ecosystem services (ES) and illuminate their values to humans in order to make environmental decisions easier and more effective. By creating ad-hoc, probabilistic models of provision, use and flows of ecosystem services in a region of interest, ARIES helps discover, understand, and quantify environmental assets, their likely beneficiaries, and what factors influence their value according to specified needs and priorities. Thanks to a grant from UNEP, the coverage of ARIES is being extended to include coastal and marine systems, which are the focus of this contribution. Ecosystem services dynamics can be seen as a generalized source-sink problem, where ecosystems are the source of benefits that meet the needs of specific human beneficiaries. Modeling ES in a given spatial and temporal context requires: (1) determining the currencies of these benefits, such as water, CO2 etc; (2) determining likely surfaces of both provision and usage relative to the area and time of interest; (3) quantifying the rates of flow of the correspondent benefits. It is the rate of flow (current or potential) that can be directly related to the value of the ES, both in abstract and in economic terms. Most of the many difficulties of modelling ES depend on the high heterogeneity of behavior exhibited by the benefits they produce. Among these: 1. Provision and usage happen at entirely independent scales in space and time. Therefore, a scale-explicit approach needs to be taken, and theoretical instruments that can tackle multi-scale systems are lacking. Recognizing the spatial and temporal decoupling between source and use, between benefits and their carriers has important implications for management, mitigation efforts, and policy actions. 2. The "currency" of benefit provision is rarely an easily modelled biophysical quantity. Easier cases include, e.g., CO2: quantification of its exchange from vegetation to atmosphere may be all that's needed to assess benefits of carbon sequestration. Things are much more complex with currencies like sense of identity or avoided risk of flooding. 3. Little clarity exists in the literature about quantifiable definition of ES, their benefits, and the modalities of their propagation from ecosystem to human beneficiary. The ARIES methodology is based on explicit conceptualizations that lay out first of all a novel vision of ES, based on the breakdown into individual benefits, each of which is modeled independently, then linked to the others. Domain ontologies in ARIES result from a large-scale expert consensus. Artificial intelligence techniques (machine reasoning, pattern recognition) examine source data and extract from the ontologies models that best represent the situation at hand. ARIES builds ad-hoc, probabilistic Bayesian Network models that inform the users of the full probability distribution of the outcomes of their decisions (Villa, 2009). The result of an ARIES user session is a set of GIS maps that describes in depth the spatial distribution of benefits produced the area, their potential and realized values, and the causal relationships that link the values to each other, to their likely beneficiaries, and to actual or potential policies. Users can enter a scenario explorer module to explore the likely changes in ecosystem service provision and usage engendered by changed environmental conditions, consequent to either natural change or their own actions. We will discuss the ARIES methodology and demonstrate the software toolkit to highlight its potential in informing ES-centric decision-making in coastal and marine decision-making.

References

1 - Villa F., Ceroni M., Bagstad K., Johnson G., Krivov S., 2009. ARIES (ARtificial Intelligence for Ecosystem Services): a new tool for ecosystem services assessment, planning, and valuation. Proceedings of the BioEcon conference, Venice September 20-23.

2 - Villa, F., 2009. Semantically-driven meta-modelling: automating model construction in an environmental decision support system for the assessment of ecosystem services flow. In: *Information Technology in Environmental Engineering*, I.N. Athanasiadis, et al., Editors. Springer: New York, NY. p. 23-36.

DESTRUCTION OF OLYMPIA'S ANCIENT HARBOUR SITE BY A TSUNAMI IMPACT

A. Vött [1]*, G. Bareth [1], H. Brückner [2], I. Fountoulis [3], F. Lang [4] and D. Sakellariou [5]
[1] Institute for Geography, Universität zu Köln - andreas.voett@uni-koeln.de
[2] Faculty of Geography, Philipps-Universität Marburg
[3] Department of Dynamic, Tectonic, Applied Geology, National and Kapodistrian University of Athens
[4] Department of Classical Archaeology, Technische Universität Darmstadt
[5] Hellenic Center for Marine Research

Abstract

This paper presents geo-scientific characteristics of a beachrock-type calcarenitic tsunamite from the Bay of Aghios Andreas (Peloponnese, Greece). Geomorphological, sedimentological, micromorphological, geochemical and geochronological studies were conducted to clarify the depositional processes and the post-sedimentary evolution. We found sedimentary structures such as basal unconformities, rip-up and intra-clasts, evidence of fining upward, thinning landward and upward increase in sorting as well as bi-to multimodal deposits all of which are described as features typical of recent or historic tsunami deposits. It is concluded that in the Bay of Aghios Andreas, Olympia's ancient harbour site was destroyed by tsunami impact.

Keywords: Beach, Coastal Processes, Eastern Mediterranean, Geomorphology, Sea Level

Tsunami hazard in the eastern Mediterranean is among the highest worldwide. This is mostly due to the high seismic activity along the Hellenic Arc where the African Plate is being subducted under the Eurasian Plate inducing numerous strong tsunamigenic earthquakes. In addition, the Arabian Plate, moving northward at fast rates, is a serious source of seismically-related hazards. Paleotsunami research in the eastern Mediterranean has been strongly intensified during the past decades, in order to improve our understanding of the dimension and the dynamics of tsunami landfalls, and to gain reliable background information for future risk assessment. In addition to archival studies based on ancient accounts and historical data, an increasing number of geo-scientific field studies have been carried out to detect palaeotsunami deposits.

A new type of event deposit, beachrock-type calcarenitic tsunamites, has been described for the first time, based on three case studies from western Greece ([1], [2]). Here, we present details from beachrock studies at ancient Pheia, the harbour site of Olympia, which is located in the Bay of Aghios Andreas in the western Peloponnese. The archaeological remains of Pheia are almost completely submerged and lie in water depths down to 5 m below present sea level. The harbor is said to have been destroyed by earthquakes in the 6th century AD, most probably in 521 AD and/or 551 AD ([3]). The modern beach of Aghios Andreas is characterized by thick beachrock layers. In former studies, this beachrock was used as sea level indicator thus explaining the submergence of ancient Pheia by a complex sequence of gradual subsidence (6.5 m) and following minor uplift (1.5 m, [4]).

We carried out geomorphological, sedimentological, geoarchaeological and geochronological studies. The basal section of the beachrock, up to 3 m thick, is lying on top of an erosional discordance and consists of abundant coarse gravel. The mid-section of the beachrock is clearly laminated and shows several fining upward sequences out of fine sand from the littoral zone. Further sedimentary structures found are convolute bedding and load casting, both untypical of littoral environments. Such characteristics rather indicate gravity-induced flow dynamics in a water-saturated suspension-like matrix. In some areas, large ashlars were found incorporated into the calcarenite. These man-made blocks, still angular, do not show any signs of being moved or altered in the littoral zone; one block is even coated with original white plaster. Moreover, vibracoring revealed clear thinning land- and sideward of the beachrock, and the beachrock was discovered up to 40 m distant from the coast and up to 2.60 m above present sea level. It is, however, known from previous studies that during the Holocene, the relative sea level in the area has never been higher than at present ([3], [5], [6]).

Based on our results, the beachrock sequence at Aghios Andreas does not reflect at all sedimentary characteristics typical of a (lithified) beach but rather represents high-energy event deposits. Convolute bedding and load cast structures are assumed to document intermittent backflow shortly after high-energy deposition of thick allochthonous sand deposits onshore. We thus suggest that Olympia's harbor site was hit by tsunami associated to strong earthquakes. Submergence of Pheia's archaeological remains seems to be of co-seismic nature such as observed during the southeast Asia tsunami in 2004.

References

1 - Vött A. and May S.M., 2009. Auf den Spuren von Tsunamis im östlichen Mittelmeer. *Geogr. Runds*., 12: 42-48 (in press).

2 - Vött A., Bareth G., Brückner H., Curdt C., Fountoulis I., Grapmayer R., Hadler H., Hoffmeister D., Klasen N., Lang F., Masberg P., May S.M., Ntageretzis K., Sakellariou D., Willershäuser T., 2010. Beachrock-type calcarenitic tsunamites along the shores of the eastern Ionian Sea (western Greece) – case studies from Akarnania, the Ionian Islands and the western Peloponnese. Z. f. *Geomorphol*. N.F., Suppl. Vol. (in press).

3 - Kraft J.C., Rapp G. (Rip), Gifford J.A. and Aschenbrenner S.E., 2005. Coastal change and archaeological settings in Elis. Hesperia, 74/I: 1-39.

4 - Fouache E. and Dalongeville R., 1998. Neotectonics in historical times: the example of the Bay of Aghios Andreas (Ilia, Greece). Z. f. *Geomorphol*. N.F., 42/3: 367-372.

5 - Vött A., 2007. Relative sea level changes and regional tectonic evolution of seven coastal areas in NW Greece since the mid-Holocene. *Quat. Sc. Rev*., 26: 894-919.

6 - Engel M., Knipping M., Brückner H., Kiderlen M. and Kraft J.C., 2009. Reconstructing middle to late Holocene palaeogeographies of the lower Messenian plain (southwestern Peloponnese, Greece): Coastline migration, vegetation history, and sea level change. *Palaeogeogr., Palaeoclimatol., Palaeoecol*., doi: 10.1016/j.palaeo.2009.10.005.

CAUSES OF INFRALITTORAL BARRENS IN THE TURKISH MEDITERRANEAN AND POTENTIAL FOR ECOSYSTEM RESTORATION

Zeynep derya Yildirim [2], Zafer ali Kizilkaya [2]*, Enric Sala [3] and Atakan Sukatar [1]
[1] Ege University
[2] Underwater Research Society - anemon@imagesandstories.com
[3] Centre d'Estudis Avançats de Blanes (CSIC), Spain

Abstract
The goal of the study was to understand rapid change of benthic communities in the Turkish Mediterranean infralittoral, from dense algal forests to barrens. We conducted caging experiments in three sites and observed that macroalgae grew rapidly inside the cages but not outside. Juvenile rabbitfish invaded the cages at the end of the experiment and removed all algae within. These results suggest that the large abundance of Lessepsian herbivorous fishes may be a major cause for the desertification of the Turkish Mediterranean infralittoral. The restoration of the ecosystem may require the removal of Lessepsian fish species.
Keywords: Algae, Biodiversity, Eastern Mediterranean, Monitoring, Lessepsian migration

Introduction
The Turkish Mediterranean infralittoral was dominated by abundant algal forests, dominated by the genus *Cystoseira* and Dictyotales, only a decade ago (pers. obs.). Current observations along the Turkish coast revealed that macroalgae have disappeared from many locales, and been replaced by extensive barrens with virtually no macroalgae. Sea urchins, which are the main cause of barrens elsewhere in the Mediterranean [1], were also absent in these barrens; but the alien herbivore from the Red Sea, the rabbitfish (*Siganus luridus* and *S. rivulatus*), was very abundant. In contrast, on Greek islands of the Dodecanese, where environmental conditions are very similar but rabbitfish were much less abundant, *Cystoseira* forests dominated infralittoral communinities. We thus hypothesized that the desertification of the Turkish Mediterranean infralittoral is due to the grazing activity of the abundant Lessepsian rabbitfish. To test this hypothesis, we conducted visual censuses of fish and benthos, and a caging experiment, in several locales of the Turkish coast.

Materials and Methods
To determine the extent of barrens and the structure of the herbivore community, we conducted underwater visual belt transects using scuba at a depth of 10m in five sites of the Turkish Mediterranean. We counted, identified, and estimated the size of all fishes within 15 replicate 25x5m transects per site, and calculated the biomass of algae by scrapping 20 25x25cm quadrats per site. We counted sea urchins using 150 50x50cm quadrats per site. In three sites with extensive barrens (Kas, Fethiye, and Bodrum) we conducted caging experiments to test wheter the absence of algae was due to the grazing by fish. We installed 12 60x40x25cm cages with plastic mesh on each site. Once a month, cages were lifted, and cages and nearby control quadrats were photographed. Algal cover of each taxa was estimated using Photogrid. A subsample of algae were collected to calculate the relationship between cover and biomass. In addition, pH, salinity, oxygen and turbidity were measured, and fish surveys were conducted around the cages.

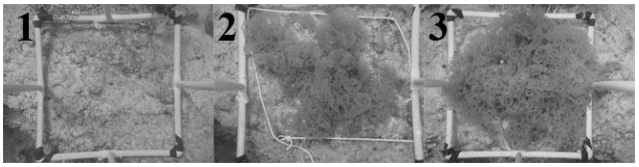


Fig. 1. Monitoring the algal growth within a cage at Kas during three months in 2009: 1) April, 2) May, 3) June

Results and Discussion
Macroalgae grew very rapidly inside the cages (Fig. 1) - in some cases from 0 to 200 g m^{-2} in four months - but not outside the cages (Table 1). Sea urchins were very rare in the study areas, and were not observed grazing around the cages. The native herbivorous fish *Sarpa salpa* was rare, but rabbitfish were very abundant throughout the study period. In September and October, rabbitfish recruitment was very high, and rabbitfish juveniles entered the cages and consumed every alga within.

Tab. 1. Algal biomass inside and outside the cages during the experimental period (g m^{-2})

Workspace		April	May	June	July	August	September	October	November
Kas	inside	59.5	95.3	95.0	200.3	68.0	0.0	0.0	9.3
	outside	0.0	0.2	0.0	69.1	42.2	0.0	0.0	0.0
Fethiye	inside	0.4	6.2	16.2	33.0	13.5	0.0	0.0	0.0
	outside	0.0	0.1	0.5	0.0	0.0	0.0	0.0	0.0
Bodrum	inside	6.6	20.2	41.7	17.8	29.3	38.4	35.3	3.8
	outside	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0

In contrast, *Cystoseira* spp and Dictyotales were observed in the mediolittoral, near the surge zone, where fish grazing activity is more limited.
These results suggest that herbivorous fishes, not sea urchins or environmental factors, are responsible for the creation of infralittoral barrens in the Turkish Mediterranean coast. This is the first documented case in the Mediterranean sea where herbivorous fishes create barrens, and where Lessepsian fishes have dramatically transformed the ecosystem, from one dominated by lush and diverse brown algal forests to another dominated by bare rock.
Restoration of algal assemblages ocurred at first successional stages and within small enclosures. The question is whether restoration efforts could be conducted at large scales. Based on our results, such restoration efforts may have to be based on overfishing of the introduced rabbitfishes *Siganus* spp.

References
1 - 1. Sala, E., Boudouresque, C.F., Harmelin-Vivien, M.L. 1998. Fishing, trophic cascades, and the structure of algal assemblages: evaluation of an old but untested paradigm. Oikos 82:425-439

ECO-HYDRODYNAMIC MODELLING OF EUTROPHICATION AND NUTRIENT CYCLES USING DELFT3D MODEL FOR THE CILICIAN BASIN

V. çaglar Yumruktepe [1]*, Baris Salihoglu [1], Temel Oguz [1] and Süleyman Tugrul [1]
[1] Middle East Technical University Institute of Marine Sciences - caglar@ims.metu.edu.tr

Abstract
Major rivers and domestic wastewater discharges from the cities of Mersin and Iskenderun exert a severe stress on the Cilician Basin ecosystem. Recent studies show that the coastal regions of the basin show eutrophic characteristics, where on the contrary, the offshore waters of the Eastern Mediterranean Sea show oligotrophic characteristics[1-2]. This study aims to model the hydrodynamics coupled with the ecosystem of the Northeastern Mediterranean Sea. The coupled model used for the study is DELFT3D of Delft Hydraulics Labs. Europhication is being observed in the hot spots of the region, and using these data specific limiting nutrients and their cycles are modelled including the life cycles of several phytoplankton and zooplankton species.
Keywords: Models, Nutrients, River Input, Primary Production, Phytoplankton

Physical, chemical, and biological properties of the basin is observed by six field surveys conducted by R/V Bilim of Middle East Technical University, Institute of Marine Sciences, within the framework of TARAL (TÜBITAK) project during September 2008 – August 2009. These cruises were conducted to observe the seasonal variations in the region, so there are winter, spring and summer data available for every field. We also collected chemical data from the related rivers. In order to analyse the eutrophication processes, a coupled physical-biological model was used. Observations were used to set the models initial and forcing fields. Two open water boundaries were included in the domain of the model being the south and west part of the basin, where the discharge of the major rivers, Seyhan and Ceyhan, and also a local river of Mersin Bay, Berdan are included. To show the effects of the domestic discharges, the discharge from the city wastewater plant of Mersin was included as inflow to the model. The studies show that the Northeastern Mediterranean Sea is phosphate limiting, but the effect of discharges show a shift in N/P ratio, especially in spring seasons.

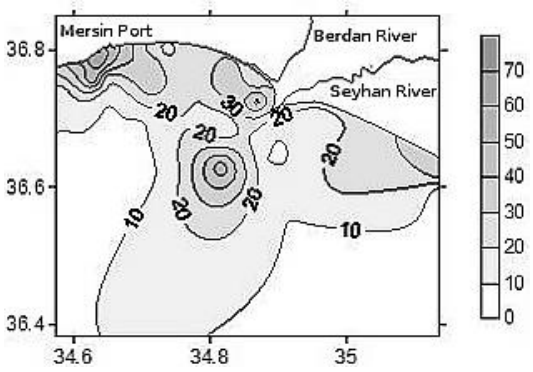


Fig. 1. Spring 2009 N/P Ratio of Mersin Bay, representing the impact of discharges

This result is clearly seen by the model as major impacts of the river discharges. At certain times of the year, the Mediterranean is under high level deposition of nutrients from the Sahara Desert, and for that reason, atmospheric calculations are included in the model. As physical forcing functions, varying heat fluxes and wind data are used in the model to force circulation and stratification and mixing of the water column in varying
seasons.

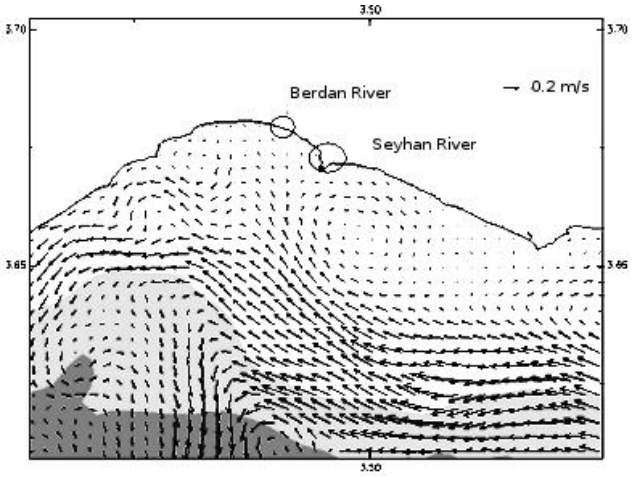


Fig. 2. Circulation model result of Mersin Bay showing the open water circulations and their effect on coastal regions

Regarding the eutrophication, four nutrients are taken as sources, NH_4, NO_3, PO_4 and Si. Three phytoplankton species are parameterized with respect to these nutrients being, flagellates, diatoms and dinoflagellates, and also general zooplankton species. Dissolved oxygen is modelled in conjunction with the eutrophication process, and biochemical oxygen demands results are observed respectively.

References
1 - TUGRUL S., Yemenicioglu S., Ediger D., Uysal Z., Mutlu E., Dogan-Saglamtimur N., Yilmaz D., Devrimci H. A., 2005. Med Poll Phase III Long Term Bio Monitoring Trend Monitoring, Compliance Monitoring and Eutrofication Monitoring Program in Coastal and Hot Spot Areas from Northeastern Mediterranean Final Report 2005, Ministry of Environment and Forestry Turkey, Pp: 336.
2 - YILMAZ A., Bastürk Ö., Saydam C., Ediger D., Yilmaz, K., Hatipoglu, E., 1992. Eutrophication in Iskenderun Bay, Northeastern Mediterranean. Sci. Tot. Environ. (Special Issue). In: Marine Coastal Eutrophication (Vollenweider, R.A., Marchetti, R., Viviani, R., eds.) Elsevier, Amsterdam, pp: 705-717.

ANTHROPISATION ET ÉROSION BIOLOGIQUE : CAS DU GOLFE DE TUNIS

Jeanne Zaouali [1]*
[1] Institut National Agronomique de Tunisie, 2025, Tunis, Tunisie - jeanne.zaouali@planet.tn

Abstract
La comparaison faite entre l'état environnemental du golfe de Tunis dans les années 70 et l'état actuel met en évidence une «dévégétalisation» sur quelques 150 km2 et une profonde déstructuration de tout l'écosystème du golfe.
Keywords: Algae, Posidonia

Le golfe de Tunis, situé à la jonction entre les bassins occidental et oriental, occupe une position clé en Méditerranée méridionale. Avec la concentration sur ses rives de près du cinquième de la population nationale (2 millions d'habitants), de l'essentiel du tissu industriel national (85 %) et l'essentiel de l'activité portuaire aussi bien touristique que commerciale, ce milieu subit de très fortes contraintes. Le poids grandissant des stress environnementaux au niveau du golfe a suscité l'attention des autorités qui ont mis en route un vaste programme de surveillance environnementale devant aboutir à des mesures de réhabilitation. Les observations faites dans les années 70 sur l'état des phytocénoses benthiques de l'ensemble du golfe (1) nous ont permis de caler un point « zéro écologique ». A des fins de comparaison, une campagne de surveillance environnementale a été faite en juin 2008. Elle a concerné 43 stations réparties sur l'ensemble du golfe (eau, sédiments et macro benthos). L'ensemble des résultats obtenus, a permis de connaître les principales réponses de l'écosystème aux stress, à savoir :

- la remontée générale de la frange basse de la végétation (fig1), celle-ci étant nettement plus forte dans toute le secteur ouest du golfe sous influence du seul fleuve tunisien pérenne, à savoir la Mejerdah, et moindre dans le secteur est où la pression anthropique directe, en dehors de celle exercée par les arts traînants, est très faible.
- l'importante diminution des surfaces occupées par les herbiers de posidonies et, dans de nombreux cas, leur disparition, notamment dans la portion ouest de la baie de Tunis - sous influence directe des contraintes liées au voisinage de la capitale-.
- engendrée par la progressive opacification des eaux chargées de particules en suspension, l'éradication sur près de 150 km2 des prairies de *Caulerpa prolifera* qui, dans les années 70 succédaient aux herbiers. Pour la même raison, la remontée des éléments de la biocénose coralligène, très importante, est passée de 50 à 10 m.

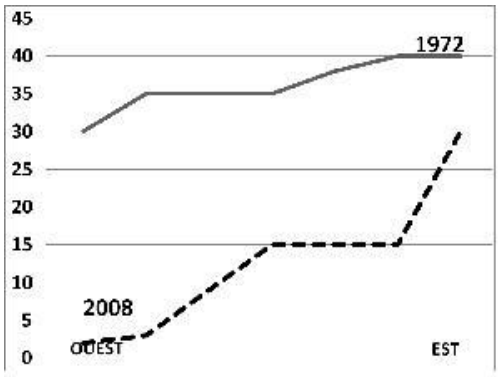


Fig. 1. Golfe de Tunis- profondeur (en mètres) de la frange basse de la phytocénose infralittorale en 1972 (trait plein) et 2008 (pointillés).

Cette déstructuration de l'écosystème littoral, sous les contraintes accrues liées au réchauffement climatique global, a laissé place à une large colonisation par des espèces exotiques tropicales et plus spécialement par *Caulerpa racemosa* qui, à l'heure actuelle, est présente tout au long du littoral du golfe.

References

1 - Ben Aleya, H ., 1972. Répartition et condition d'installation de *Posidonia oceanica* Delile et *Cymodocea nodosa* Ascherson dans le golfe de Tunis. *Bull. Inst. Océanogr. Pêche* (Salammbô), 2 (3): 331-416.